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EXPORTING POLLUTION

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ABSTRACT

Despite awareness of the detrimental impact of CO2 pollution on the world climate, countries vary widely in how they design and enforce environmental laws. Using novel micro data about firms' CO2 emissions levels in their home and foreign countries, we document that firms headquartered in countries with strict environmental policies perform their polluting activities abroad in countries with relatively weaker policies. These effects are stronger for firms in high-polluting industries and with poor corporate governance characteristics. Although firms export pollution, they nevertheless emit less overall CO2 globally in response to strict environmental policies at home.

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1 Introduction

Despite wide agreement among scientists that carbon dioxide (CO_2) pollution is the primary cause of global warming, countries apply different standards to combat such pollution. Around the globe, countries take different approaches, ranging from stringent environmental laws and strict enforcement to lenient rules, and some turn a blind eye to CO_2 polluting activities (Stern 2008). Given the inconsistency in environmental laws and in their enforcement, some economists have proposed the pollution haven hypothesis (PHH), which asserts that firms move their polluting activities to countries with weak environmental policies (Eskeland and Harrison, 2003; Cole, 2004, among many others). An important implication of the PHH is that strict environmental policies by individual countries may have little effect on global pollution levels, because they crowd out pollution toward countries with more lenient environmental policies (see theory by Hambel, Kraft, and Schwartz, 2018). Several previous studies have attempted to test the PHH using aggregate data (e.g., country level), but the researchers did not have the data necessary to directly measure pollution.

In this study, we test the PHH using a unique panel dataset of CO_2 emissions by large public firms in each country in which they operate. Using these data, coupled with information on the stringency of national environmental policies by country and year, both in the firms' home markets and abroad, we test whether firms actually pollute more in countries with weak environmental laws and enforcement. Our results provide novel direct evidence about the PHH in addition to new results from the cross section of firms and countries. These findings support the conjecture by Hambel, Kraft, and Schwartz (2018) and Shapira and Zingales (2017) that abatement efforts come at the expense of investment and trade, and thus polluting activities are transferred to countries engaging in the lowest abatement efforts.

The main prediction of the PHH is that polluting industrial activities take place more intensely in countries with weaker environmental policies due to a combination of both demand and supply effects. From the demand side, firms transfer their polluting operations to countries with weak environmental laws and weak enforcement. The idea is that restricting emissions is costly for firms; therefore, they seek countries with emissions-friendly environmental policies. From the supply side, countries may be able to attract polluting firms by providing weak environmental policies and lax enforcement of those policies. Countries impose relaxed environmental policies so they can benefit from the economic activity (e.g., employment, investments) industrial production brings.

We provide two main sets of tests for the PHH. The first set, which is based on aggregate firm-year data, examines the PHH and its implications. We test whether firms tend to pollute more abroad given the strictness of environmental policies in their home country, that is where the firm's headquarter is located. We also investigate how the strictness of environmental policies in their home country affects firms' total global emissions. We find that a one-standard-deviation increase in the strictness of environmental policies is associated with up to a 29% decrease in emissions from the firm's operations at home, and up to a 43% increase in emissions from operations in foreign countries. Importantly, although firms appear to emit more CO_2 abroad, stricter environmental policies at home are associated with lower global pollution overall. A one-standard-deviation increase in the strictness of environmental policies in the home country is associated with about 15% lower global CO_2 emissions overall.

We also explore the cross section of firms. For firms that are considered to have good governance, we find that effects are generally stronger, meaning that when the home country sets strict environmental policies, firms commonly considered to have good governance structures

produce fewer emissions at home and export fewer emissions to foreign countries. This result is interesting as firms face a tradeoff between pollution and value. At least in the short run, firms may prefer to pollute in order to save on the costs associated with clean production (see the Dupont case in Shapira and Zingales 2017). Good governance mechanisms may dissuade managers from pursuing such short-term goals and push them toward production with lower emissions. One explanation for this result is that good governance is generally associated with an investor base that values corporate responsibility practices and therefore puts pressure on management to pursue socially and environmentally responsible goals, including lower emissions.

We next split the sample by industry: high- versus low-polluting industries. We document that firms' behavior with respect to environmental policies is more accentuated when they are part of high-polluting industries. Compared to firms in low-polluting industries, firms in high-polluting industries do not reduce emissions at home while at the same time exporting more pollution abroad. This finding is consistent with the idea that strict environmental policies are costly for firms in high-polluting industries, causing them to attempt to avoid the cost by exporting pollution to foreign countries. Consequently, policymakers might have a greater impact on global emissions if they target these high-polluting industries.

In a second set of tests, we explore to which countries firms export their pollution. By drawing on the international trade literature and using a gravity model, we examine whether the relative strictness of environmental policies in the home country versus the foreign country is correlated with more pollution abroad. We document that firms pollute more abroad when the gap in the strictness in environmental policies between home and the foreign countries in which they operate is greater. Thus, the "distance" in policy strictness predicts whether and the extent to which such exporting takes place.

Overall, we find support for the main prediction of the PHH, that firms perform their polluting activities outside the borders of their home country when that country imposes strict environmental policies. In other words, strict environmental regulation is associated with lower firm-level emissions at home. Furthermore, countries with lenient environmental policies tend to attract polluting activities from firms headquartered in countries with stricter policies. Our findings, however, do not fully support the PHH's implication that strict environmental policies by individual countries have little effect on global pollution levels. Instead, we find that firms pollute less on a global level when their home countries impose strict environmental policies.

Our work follows decades of research during which environmental economists developed the PHH. Leonard and Duerksen (1980) and Walter (1982) conducted early studies proposing a link between aggregate industrial pollution and countries' environmental laws. Several later studies explored the theoretical conditions under which the data are likely to confirm the PHH. Socolow (2006) analyzed the different paths that policy can take to reduce carbon emissions over the next 50 years. Numerous studies correlate aggregate measures of trade and investment with environmental policy (see Ederington, Levinson, and Minier (2005) for a critical assessment of the empirical evidence). Taylor (2005) explores the theoretical implications of the PHH and reviews the literature on the topic. Bommer (1999) proposes a theoretical extension to the PHH, showing that producers relocate their manufacturing facilities to countries with weak environmental law enforcement to warn home regulators against further tightening environmental regulations.

Prior studies generally test the PHH using aggregated data at the industry- or country-level and indirect and high-level proxies for pollution. Several studies correlate aggregate industrial activity and the stringency of environmental laws in home countries compared to target countries (Shafik and Bandyopadhyay, 1992; List, 2001; Cole and Elliott, 2005; MacDermott, 2009; Wagner

and Timmins, 2009; Kalamova and Johnstone, 2011; Ben Kheder and Zugravu, 2012). Many of these studies are not able to observe environmental regulation and thus use country-level proxies such as aggregate actual pollution, pollution abatement costs, or income as proxies for the weakness of regulation. Other studies find a correlation between trade flows and country- or industry-level environmental regulations (Cole, 2004; Levinson and Taylor, 2008; Kellenberg, 2009; Kearsley and Riddel, 2010). Grossman and Krueger (1995) document that per capita income is negatively correlated with pollution levels. Millimet and List (2004), Aliyu (2005), and Mulatu, Gerlagh, Rigby, and Wossink (2010) find that the location of manufacturing facilities in developed countries (e.g., OECD, European countries) is correlated with the stringency of the home environmental policy. Peters et al. (2012) show that global carbon emissions dropped temporarily around the 2008 financial crisis due to a decline in global production. Using multinational industry-level data, Kellenberg (2009) finds that environmental policies prevent polluting industrial activities. Esty and Porter (2005) argue that countries' environmental policies not only depend on income levels but also on their social and cultural context.

At the micro level, evidence on firm pollution and environmental policies is limited and, again, only indirect. To the best of our knowledge, all studies that use micro-level data estimate whether firms are more likely to have facilities in countries with weak environmental policies *without* observing actual pollution levels. Sen (2015) estimates a structural model that proposes that stringent environmental laws and enforcement lead to greater innovation and research and development (R&D) activity. He finds confirming evidence for the model in the auto industry. Dam and Scholtens (2012) document that firms with a lower environmental responsibility qualitative index score are more likely to manufacture in countries with weak environmental regulation. This index is composed by the Ethical Investment Research Service and characterizes

firms according to their ethical conduct on multiple dimensions. Becker and Henderson (2000, 2001) find that industries in the United States reacted to a specific environmental regulation that applied only to large plants by moving production to smaller facilities. Ben Kheder and Zugravu (2012) use firm-level location data to study the link between location decisions and local environmental laws. They find that firms are more likely to have facilities in countries with weaker environmental regulations, as measured by the degree of international environmental agreements, NGO (nongovernmental organizations) activity, and energy efficiency.

2 Data Description

2.1 CO_2 Emissions Data

Our main source is a large database provided by CDP (formerly known as the 'Carbon Disclosure Project') that contains self-reported responses of firms about their national and global CO_2 emissions. CDP is a UK-based "not-for-profit charity that runs the global disclosure system for investors, firms, cities, states, and regions to manage their environmental impacts" (CDP, 2017). As of 2017, more than 800 institutional investors with US$100 trillion in assets were supporting the CDP and its initiatives. Since CDP's inception, the number of institutional investors that became signatories of CDP has grown tremendously as has the assets under management represented by those investors. The CDP began by only surveying UK-based FTSE firms but now obtains climate-change and pollution information from firms around the world.

Our dataset consists of annual survey data from firms between 2008 and 2015. Over this period, CDP increased its outreach from about 3,000 to more than 6,000 firms worldwide. CDP sends its survey to the largest firms in the world, most of which have publicly traded equity. The

questionnaires ask firms about their CO_2 emissions, their various approaches to combatting climate change, and the practices they use to manage potential risks stemming from climate change. In this study, we focus on the questions that ask firms about CO_2 emissions that stem both directly and indirectly from their operations. The answers to these questions allow us to directly measure firm-level emissions and identify the countries in which these emissions are made. Overall, the firms in our sample emit CO_2 in more than 200 different countries. We have pollution information on firms that operate in multiple countries as well as firms that operate in a single country (about 11% of the sample). This information is a clear data advantage over other studies that use micro-data; prior studies focus on multinational firms exclusively and thus ignore the decision to transfer some operations outside the home country (see, e.g., Dam and Scholtens, 2012). We create a panel dataset containing annual CO_2 emissions information for firms in each country in which they operate.

We have two measures of CO_2 emissions: Scope 1 and Scope 2. Scope 1 emissions are the total CO_2 emissions (in metric tons) that stem directly from the operations of the reporting firms. Scope 2 emissions are the total CO_2 emissions arising from the production of the electricity the firm purchases to run its operations and over which it does not have direct influence. The firm estimates this quantity based on a breakdown of the electricity sources used in the respective country. Hence, Scope 2 measures emissions that take place upstream in the supply chain, in metric tons.

One caveat to this dataset is that it contains voluntary, self-reported firm information. Firms are pressured to report their degree of pollution by institutional investors and regulators who demand greater transparency about the environmental impacts of their business and how climate change affects the long-run viability of the business. Investors, especially long-term institutional

investors such as pension funds and insurance companies, need to understand the long-run implications of tightening climate-change and environmental regulations resulting from the Paris Agreement on climate change, which was agreed upon in 2015 and subsequently has been implemented by most signatory countries. In addition, institutional investors are interested in learning about firms' exposure to climate change and environmental issues to identify business models that are at risk or less resilient.

Despite the self-reported nature of our data, we have good reason to believe that the emissions information is accurate and close to actual emissions. First, prior research shows that firms report emissions rates that are at least as high in their sustainability reports (like CDP) as in their annual financial reports (Depoers, Jeanjean, and Jérôme, 2016). Second, some firms have begun requiring their auditors to approve the statistics in the sustainability reports. We have information on whether firms had their auditors verify the CO_2 information and which reporting standard they applied.[1] We use this fact to provide some assurance regarding the quality of the data and hence the results. When we restrict the sample to those observations for which the emissions information has been verified by external parties such as the firms' auditors, the main results are similar to those we obtain using the full sample. We discuss these robustness tests and results together with the main test results in section 3.

In addition, any bias in the self-reporting should bias our results *against* finding supporting evidence for the PHH. (Firms might attempt to hide their emissions activity in foreign countries.)

[1] The CDP data contain information on how and to what extent the firms' auditors or other third parties have verified the reported carbon emissions. The dataset also contains information about what reporting standard or framework was applied to verify the carbon emissions, such as, for example, ISO14064-3. Furthermore, companies usually disclose in their annual reports or sustainability reports whether the reported information on carbon emissions therein has been verified and, if so, by whom.

If anything, our results are likely to show a lower bound for the effect, because pollution reporting is voluntary and the reporting firms may be less aggressive than nonreporters.

Given that the CDP is an investor-supported initiative, a natural regulatory mechanism is also at work that ensures the firms' reported information is generally credible and trustworthy. Investors are pushing firms to participate in the CDP and report through it, as well as facilitating discussions between CDP and firms when disagreements arise about the scores CDP assigns to firms' survey responses. After all, firms have an incentive to report truthful information through CDP: Reporting inaccurate information on its climate change policies and emissions levels could carry significant litigation risks in some jurisdictions.

2.2 Environmental Laws and Enforcement Data

The other major component of our analysis is data about the strictness of environmental laws and enforcement at the country level. We use a dataset compiled by the World Economic Forum (WEF) that covers the 2008–2015 period and is publicly available on a bi-annual basis for 150 countries.[2] Countries are assigned two rankings on a scale from 1 to 7: (1) the stringency of their environmental regulation (SER) and (2) how strictly these laws are enforced (EER). WEF generates these rankings based on surveys of top local business leaders.[3] This fact helps the validity

[2] See Travel & Tourism Competitiveness Reports of WEF, e.g., https://www.weforum.org/reports/the-travel-tourism-competitiveness-report-2017.

[3] These rankings were obtained from the WEF's Executive Opinion Survey conducted annually among more than 14,000 business leaders worldwide. The relevant survey questions are as follows: (1) How would you assess the stringency of your country's environmental regulations? and (2) How would you assess the enforcement of environmental regulations in your country? Answers range from 1 (very lax) to 7 (among the world's most rigorous). According to the WEF, its survey "captures the opinions of business leaders around the world on a broad range of topics for which data sources are scarce or, frequently, nonexistent on a global scale. It helps to capture aspects of a particular domain … that are more qualitative than hard data can provide" (Schwab and Sala-i-Martin, 2016:85). The WEF survey measures are highly correlated with policy-based indices such as the EBRD's CLIMI index or the OECD's EPS index (Botta and Koźluk, 2014) but have the advantage of being available for a large number of countries over time.

of our results, because the WEF measure reflects scores as perceived by corporate leaders, who eventually respond to this perception by determining the location of polluting activities.

WEF produces two environmental policy measures, stringency of environmental regulation and stringency of enforcement, which are highly correlated (correlation coefficient of 0.97). We assume a country needs both components, laws and enforcement, to have a robust environmental policy in place. Stated differently, an inherent interaction exists between these two dimensions: Strict environmental laws must be enforced to make a difference. Because of the high correlation of these variables, introducing both into the regression simultaneously induces severe multicollinearity. To remedy this issue, we adopt three approaches. The first is to combine the two scores into a single variable: $SEER = \frac{1}{7} SER * EER$. We call this measure stringency and enforcement of environmental regulation, or *SEER*, and its value ranges from 0 to 7. The other two approaches involve examining the effect of each variable in isolation, and orthogonalizing the variables so that we can introduce both into the regressions. We implement these approaches in the analysis found in the Appendix and discussed later in the study. Overall, our results largely remain robust across the three methods.

2.3 Firm-level Financial Data

We obtain financial information about multinational firms and the countries in which they operate from commonly used databases. We use firm-specific financial statement data from Worldscope and country-specific macro-economic data from the World Bank's World Development Indicators. We also collect classic gravity proxies such as geographical distance, common border, colonial history, and logged annual trade between the firm's home country and

the country in which it emits CO_2. These proxies come from distancefromto.net, Andrew Rose's website (see Glick and Rose, 2016), and the IMF's Direction of Trade Statistics. Finally, as our measure of the corporate governance quality of firms, we use the corporate governance score, *CGVSCORE*, from the Asset4 database, which is widely used in academic research as well as by long-term institutional investors who assess the quality of firms' corporate governance. The score ranges from 0 to 100 and measures as a percentage the quality of a firm's governance systems and processes, ranging from board structure and compensation arrangements to a firm's treatment of shareholder rights. A higher *CGVSCORE* value indicates better governance. Variable definitions and sources can be found in Appendix Table 1.

The final dataset that we construct is a three-dimensional panel of the firm-country-year that contains the amount of CO_2 emissions by each firm in each country in each year. Naturally, most of our emissions observations have a value of zero, because each firm has operations only in a few countries.

2.4 Summary Statistics

2.4.1 Pollution and Environmental Regulation over Time

Table 1 reports summary statistics over the sample period of 2008 to 2015, including the number of unique firms, their global and home-country emissions, and the number of countries in which each firm has emissions. For the average firm, global emissions in tons decrease over time for Scope 1 and 2. Note, however, that, on average, the majority of emissions arise from the direct Scope 1 emissions. On average, Scope 1 emissions decrease from about 5 million in 2008 to 2.6 million metric tons in 2015. Most CO_2 is emitted at home, but the share of home emissions in

global emissions decreases substantially over time (from 72% to about 57% for Scope 1 emissions). Thus, over time, the average firm emits more abroad. In addition, the number of countries where the average firm's emissions take place increases from 6.0 (6.8) countries in 2008 to 9.0 (10.6) in 2015 for Scope 1 (Scope 2). Taken together, these results could be a first indication that firms shift emissions abroad over time. However, the observed trends might simply be driven by CDP's coverage of more and smaller firms or an increasing globalization of firms and thus be unrelated to environmental regulation. Therefore, in the empirical results that follow in this paper, we control for firm size and increasing globalization in various ways.

As described earlier, our measure of environmental regulation is SEER, which is the product of measures of the environmental strictness score (ranging from 0 to 7) and the environmental enforcement score (ranging from 0 to 7). Panel C of Table 1 indicates that SEER generally increases over time, both on average and at the median. The panel shows that the average score for environmental regulation improves slightly at the global average, with most of the improvement occurring among the 50 countries that had the weakest environmental policies in 2008. This finding suggests a convergence of environmental regulation over time. Furthermore, comparing means and medians reveals that the distribution of environmental regulation is skewed, with most countries being weakly regulated.

Environmental regulation varies greatly across the globe. Figure 1 uses heat maps to present country-level environmental regulation at the beginning and end of our sample period. The map shows a general improvement in environmental regulation over time; however, large regions exist where environmental regulation is weak, especially in developing countries in Africa, South America, and Asia.

This relative stability of environmental regulation for a given country implies that our empirical analyses will provide micro-evidence for the equilibrium outcome rather than identify the demand and supply effects. Our results will be driven primarily by cross-sectional variations in environmental regulation across countries rather than the response of firms to substantial changes in national regulations.

Figure 2 presents a visualization of the relationship between environmental regulation in the firm's home country (as measured by our proxy SEER) and firm-level emissions abroad. Each bubble represents all pooled firm-year observations and the respective SEER category for environmental regulation in the home country, with 7 representing the most stringent regulation and 1 the weakest. Panel A shows Scope 1 emissions, and Panel B shows Scope 2 emissions. Two observations can be made: First, bubbles move from the top left to the bottom right, implying firms in home countries with stronger environmental regulations pollute less at home and thus shift a higher fraction of their total emissions to foreign countries. Second, bubbles get bigger as we move from the top left to the bottom right, indicating that per dollar of firm assets, firms in countries with stronger regulations emit more tons of CO_2 abroad. This pattern is similar for Scope 1 and 2 emissions and supports the PHH with respect to home-country environmental regulation.

2.4.2 Firm-level Summary Statistics

Table 2 presents summary statistics for our sample firms. We find that, on average, firms emit more in their home countries than abroad (1.85 million tons vs. 1.30 million tons for Scope 1 emissions and 0.37 million tons vs. 0.30 million tons for Scope 2 emissions). On average, 38.3% (42.8%) of firms' Scope 1 (Scope 2) emissions are emitted abroad. Regarding the firms' exposure to environmental regulation, we find that the average SEER for a firm in our sample is 4.11,

whereas the strictness score of the environmental regulation is on average 5.43 and the score for the enforcement of environmental regulation is only 5.23. The average firm in our sample has US$60.7 million in assets and a foreign asset share of 26.4%. The average firm in our sample has a corporate governance score of 65 (out of a range of 0 to 100). Panel B of Table 2 provides additional country-level statistics that we use in our empirical analyses as control variables.

3 Empirical Design and Results

3.1 Polluting at Home or in Foreign Country

To test whether firms pollute more in countries with weak environmental policies, that is, those that have low SEER scores, we explore the determinants of location of pollution using the following dependent variables: logged global emissions of CO_2,[4] logged emissions in home country, logged emissions in foreign countries, and foreign emissions as a percentage of global emissions. Our main variable of interest is SEER, the combined variable of environmental policy and enforcement strictness. Other independent variables include logged firm assets, the share of foreign assets, and logged gross domestic product (GDP) in the home country, in addition to year and industry fixed effects. Standard errors are clustered by firm.

The results are presented in Table 3. Panels A and B show evidence for Scope 1 and Scope 2 emissions, respectively. Columns (1) and (2) regress the logged global emissions in tons on SEER and control variables. The coefficient on SEER is negative, indicating firms exposed to strict environmental policies in their home country pollute less globally. A one-standard-deviation increase in SEER (0.90) is associated with a 15% decrease in global emissions (controlling for

[4] We add one to all emissions variables before logging them.

firm size, home-country characteristics, and year and industry fixed effects).[5] The results for Scope 2 emissions in Panel B are of similar magnitude. These effects are not only statistically significant but also economically relevant: For the average firm that emits 3.15 million tons of global Scope 1 CO_2 each year, a 15% reduction amounts to 472,500 tons of CO_2 each year.

The results are robust to regression specification. In the regressions presented in Column (2) of Panels A and B of Table 3, we also control for a firm's share of assets that are located abroad. We include this independent variable, which is mainly driven by factors other than environmental regulation, to control for the higher likelihood of foreign emissions when the firm has more assets located abroad for reasons other than environmental regulation, such as labor cost or closeness to customers. Our previously documented results remain unchanged, and we find that a firm's share of foreign assets does not influence its global emission levels in either direction. Overall, these results do not support the implication of the PHH that an individual country's strict environmental policies have little effect on global pollution levels. Instead, we show that national regulations can be beneficial because firm highly regulated in their home country pollute less globally.

We next turn to the main prediction of the PHH and explore the emissions in logged tons of CO_2 in the home country and in foreign countries in Columns (3)–(4) and (5)–(6), respectively. Because some firms have zero emissions in their home countries, we use a Tobit model for this specification.[6] Here the effect is larger: A one-standard-deviation increase in SEER is associated with up to a 29% decrease in emissions at home.[7] By contrast, a one-standard-deviation increase in the strictness of environmental policies at home is associated with up to a 43% increase in

[5] $\%\Delta y = 100 * (e^{\beta * \Delta x} - 1) = 100 * (e^{-0.18 * 0.9} - 1) = -14.96\%$.
[6] Because the fraction of observations that is censored is relatively low in our sample, we re-estimate all Tobit regressions in Tables 3 to 5 and Appendix Tables 3 and 4 as OLS. Results are provided in Internet Appendix.
[7] From Column (3): $100 * (e^{-0.38 * 0.9} - 1) = -28.97\%$.

emissions abroad.[8] As for Scope 2 emissions, Panel B shows that a one-standard-deviation increase in SEER is correlated with a 54% decrease in local emissions and a 45% increase in foreign emissions.[9] For both Scope 1 and Scope 2 emissions at home, we find that a higher foreign asset share significantly reduces a firm's emissions at home; however, this effect does not cancel out the influence of countrywide environmental legislation and the enforcement thereof. Our results can be interpreted in the context of Walker (2011) who shows that stricter environmental regulation in the US in form of the Clean Air Act lead to plant-level downsizings and ultimately lower sector-level employment. Lower production at home rather than investment in green technology might thus be responsible for at least part of the reduced home country emissions.

Columns (7) to (8) reaffirm the previous findings by documenting the relation between environmental regulation and foreign emissions as a percentage share of total global emissions. Specifically, a one-standard-deviation increase in the strictness of environmental policies is associated with a 4.1% greater share of foreign emissions.[10] The result for Scope 2, in Panel B, shows a greater corresponding effect of 6.6%.[11] As foreign Scope 1 (2) emissions amount to 38.3% (42.8%) of total global emissions for the average firm in our sample, these effects are substantial and economically meaningful.

Overall, the findings in Table 3 show that firms headquartered in countries with stricter environmental policies emit less CO_2 globally. However, with stricter environmental regulation, the CO_2 emissions at home are significantly lower but foreign emission levels (in absolute and relative terms) are significantly higher. This latter finding is evidence in favor of the main

[8] From Column (5): $100 * (e^{0.40 * 0.9} - 1) = 43.33\%$.
[9] For Column (3): $100 * (e^{-0.48 * 0.9} - 1) = -54.03\%$; for Column (5): $100 * (e^{0.41 * 0.9} - 1) = 44.63\%$.
[10] $4.54\% * 0.9 = 4.09\%$.
[11] $7.38\% * 0.9 = 6.64\%$.

prediction of the PPH, that polluting industrial activities take place more intensely in countries with weaker environmental policies. The former finding, however, does not support another implication of the PHH that would put into question the effectiveness of country-level environmental regulation, that strict environmental policies by individual countries have little effect on global pollution levels.

3.2 Role of Corporate Governance

Corporate governance is potentially an important factor affecting how firms respond to a country's environmental policies. Generally, good corporate governance means that managers look after the interests of their investors. Traditionally, the interests of investors have been confined to their financial interests; therefore, firms with good corporate governance are expected to minimize costs.[12] In the context of the PHH, this means that firms with good corporate governance are more likely to shift emissions to foreign countries when home environmental policies are strict.

To explore the role of corporate governance in moderating the correlation between the degree of CO_2 emissions and environmental policies, we interact SEER with a dummy variable indicating good corporate governance practices. The dummy is based on the CGVSCORE from the Asset4 dataset and receives a value of 1 for a score that is above the annual in-sample median.

[12] In recent years, a growing number of institutional investors are also interested in nonfinancial returns, that is, firms should not only look after their financial stakeholders but also other material stakeholder groups that are crucial for the long-term business success of the company. For example, Hermes Investment Management stipulates that its mission is to generate so called 'holistic returns', returns that "go far beyond the financial and consider the impact our decisions have on society, the environment and the wider world." (see https://www.hermes-investment.com/ukw/wp-content/uploads/sites/80/2017/07/Hermes-Delivering-Holistic-Returns.pdf , page 1) Also, in 2017, Larry Fink — the CEO of Blackrock, the largest asset management firm — explained in his Annual Letter to CEOs of firms in which Blackrock invests that their firms should not only generate financial returns for their investors but also benefit society. See https://www.blackrock.com/corporate/investor-relations/larry-fink-ceo-letter.

The CGVSCORE takes into account more than 250 individual governance aspects of the firm in the areas of board structure, compensation policy, board functions, shareholder rights, and strategy. As reported in Panel A of Table 2, the average corporate governance score in our sample is 65.1% and the median is 76.5%.

The corporate governance analysis is presented in Table 4. The regression results show that firms with above-median good corporate governance are more sensitive to home environmental policies, that is, they emit less in their home country when environmental policies are strict (Column (2)). The results in Panel A document that whereas poorly governed firms have higher foreign emissions when home environmental policies are strict, well-governed firms do *not* emit more Scope 1 emissions abroad (the interaction cancels out the main effect; see the F-test in Column (3)). Well-governed firms thus reduce emissions at home while keeping foreign emissions unchanged. This leads to an overall higher percentage share of foreign emissions (the interaction adds to the main effect; F-test for Column (4)) but this effect is mechanical, meaning that it is driven by reduced home emissions but not by increased foreign emissions.

There could be multiple non-mutually exclusive explanations for these effects. First, managers in well-governed firms may have genuine interest in sacrificing short-term gains for long-term benefits to the firm and its stakeholders (see Shapira and Zingales, 2017, for a case study of pollution by Dupont). Second, well-governed firms may attract investors who care about corporate responsibility actions and push for such investments. In other words, good corporate governance is a proxy for a strong shareholder base that pushes such an agenda (see Footnote 12).

Panel B presents similar results for Scope 2 emissions. Again, well-governed firms are over twice as sensitive to strict environmental policies in the home country relative to firms with below-median governance scores. These firms are less sensitive to environmental policies when deciding

on polluting in foreign countries (Column 3). As with Scope 1, firms with good corporate governance emit overall a larger fraction of their global emissions abroad (Column 4).

3.3 Pollution-Intensive Industries

We next examine whether firms adjust their behavior with respect to home-country environmental policy differently across industries. In particular, we are interested in the industries that are pollution-intensive, as by definition these industries account for most emissions. The underlying hypothesis in this section is that firms in pollution-intense industries are more likely to shift their emissions abroad rather than try to minimize them in the home market.

We use a dummy for firms in industries with high pollution intensity. We base our indicator on the definition used by the European Union (EU),[13] which measures the kilograms of CO_2 emitted in generating one Euro of gross value added. The industry-year table provided by the European Union is presented in Appendix 2, and Figure 4 shows the industry averages in graphical form. The chart clearly shows three groups of polluting industries. The top two industries — electricity, gas, steam and air conditioning supply, and manufacturers of coke and refined petroleum products — emit around 6 kilograms of CO_2 per one Euro of gross value added. The next four industries — air transport, water transport, manufacture of other nonmetallic mineral products, and manufacture of basic metals — emit between 3 and 4 kilograms of CO_2 per one Euro of gross value added. All other industries emit less than 2 kilograms of CO_2 per one Euro of gross value added. Based on these figures, we define pollution-intensive firms as those in the top six polluting industries.

[13] See http://ec.europa.eu/eurostat/web/environment/emissions-of-greenhouse-gases-and-air-pollutants/air-emission-accounts/database.

Appendix Table 2 presents the summary statistics for all firm-years that can be matched to the EU's industry classification (Panel B), firm-years classified as nonpolluting (Panel C) and those classified as pollution-intensive (Panel D). Only 6.5% of all firm-years for which we have matched industry information are classified as pollution-intensive. Yet, the total emissions of Scope 1 CO_2 by this small fraction of firms is as large as the total emissions by the rest of the sample (93.5%).[14]

With this definition of polluting industries, we test whether their sensitivity to environmental policy strictness is different from that of firms in nonpolluting industries. The industry analysis is presented in Table 5. Focusing first on Scope 1 emissions (Panel A), the regressions in Columns (1) and (2) show that firms in pollution-intensive industries are not sensitive to environmental policies in regard to their global emissions or home emissions (F-test is not statistically significant). In contrast, Column (3) shows that in regard to the emissions in foreign countries, these firms are twice as sensitive to home environmental policies. Hence, when home environmental policies are strict, firms in pollution-intensive industries emit significantly more in foreign countries. Panel B presents the corresponding results for Scope 2 emissions. Overall, the results are similar, albeit not identical. Columns (1) and (2) show that firms in pollution-intensive industries are sensitive to home environmental policies to a lesser degree than firms in non-pollution-intensive industries. Columns (3) and (4) show analogous results to those in the corresponding columns in Panel A: Firms in pollution-intensive industries have nearly double the sensitivity to home environmental policies when it comes to polluting in foreign countries.

[14] Firms in pollution-intensive industries are responsible for 52% of global Scope 1 CO_2 pollution. We reach this conclusion by summing the tonnage of CO_2 emissions across all firm-years in both parts of the sample.

These results are especially important because firms in pollution-intensive industries emit materially greater amounts of CO_2. Thus, environmental policies that target these industries may be more effective in reducing total emissions. At the same time, our results show that firms in these industries are polluting significantly more in foreign countries when their home country has more stringent policies. This effect potentially indicates that the cost of reducing emissions in these industries is high, causing firms to transfer polluting activities abroad.

3.4 Where Do Firms Export Pollution to? Results from a Gravity Model

We have documented that firms pollute less in their home country and more abroad when their home country has strict environmental policies. An important question is to which countries firms export their pollution. More specifically, the PHH predicts that firms pollute in foreign countries that have weak environmental policies. To investigate this issue, we use a gravity model. Whereas in the previous specification we focused on the environmental policies in the home country, the gravity model allows us to explicitly investigate in what way the "distance" between home and foreign environmental policies is related to the location of emissions. We use the gravity model to test the hypothesis that a firm's tendency to transfer polluting activity to foreign countries increases with the gap between the environmental policies in the home country and those of the foreign country. Put differently, countries with laxer or less stringently enforced environmental policies may "attract" pollution from firms based in countries with very strict environmental policies.

Figure 3 provides an intuitive visualization of the gravity model approach to the PHH. In this model, we focus on the emissions of firm *i* in foreign country *c* in year *t*. The variable of interest is the spread between the SEER of the firm's home country and the SEER in foreign

country *c*. On the x-axis, the left bars represent observations with stronger environmental regulations abroad; the middle bars represent observations with similar environmental regulations at home and abroad; and the right bars represent observations with stronger environmental regulations at home. The y-axis shows tons of CO_2 emissions per GDP of the foreign country, which is averaged across all firm-country-year observations. Panel A includes all observations for which the SEER in the home and foreign country is known. Panel B includes only those observations from firms with nonzero emissions in foreign country *c* in year *t*. The bars increase from left to right, especially in Panel B. The pattern in this chart is consistent with the PHH and indicates that firms emit in those foreign countries where the gap in environmental regulation is most favorable to them.

To implement the gravity model empirically, we use the following procedure. We create a large matrix that has a cell for each firm-country-year combination (assuming the firm was in our database that year). In each cell, we record the pollution of the firm in the country during the specific year. Importantly, we also have a cell for firm-country-years in which no activity was recorded. In fact, about 95% of our dataset has zero activity. We drop all cells relating to the firm's activity in their home country because our intention is to study the choice of foreign country of pollution.

Our variable of interest in the gravity model is the distance, or *difference*, between $SEER_{Home}$ and $SEER_{Foreign}$,[15] which are the environmental policy scores for the home country and the foreign country, respectively. Positive (negative) values indicate the regulation is stronger (weaker) at home. The higher the value of SEER, the stronger the regulation at home is relative to

[15] Calculated as $SEER_{Home} - SEER_{Foreign}$.

the foreign country. Note that the home country is a stable firm-level characteristic, whereas the foreign country changes from one cell to another.

Table 6 shows the results of the gravity model. In the regressions, we regress either the logged CO_2 emissions (in tons) or the percentage of global emissions the firm emits in the foreign country. On the right-hand side, our main variable is the difference in SEER scores between the home and foreign country. As before, we control for logged firm assets and the share of foreign assets. In addition, we control for the foreign country's GDP and also provide controls that reflect the relations between the home and foreign countries: logged geographic distance (in kilometers), whether the countries share a common border, and whether the countries share a colonial history. We also include year, industry, foreign-country, and home-country fixed effects.

In all regressions in Table 6, we estimate a positive coefficient for SEER. These results indicate that foreign emissions are higher in countries where environmental regulation is weaker than in the firm's home country. The effects are sizable: a one-standard-deviation (1.52) increase in the relative strictness of the environmental policies at home compared to abroad is associated with an up to 84% increase in emissions in the respective foreign country.[16] This finding is consistent with the PHH, which postulates that firms export pollution to countries where environmental regulation is relatively weaker.

The other control variables have the expected signs: Emissions are higher for larger, more international firms and when countries are geographically closer, trade more with each other, or share a colonial history. The more internationally a firm operates, the higher its foreign emissions.

[16] From Column (1): $100 * (e^{0.40 * 1.52} - 1) = 83.68\%$; from Column (3): $100 * (e^{0.38 * 1.52} - 1) = 78.18\%$.

These results make intuitive sense considering that emissions are the direct result of a firm's production or operations.

3.5 Additional Tests and Robustness Checks

3.5.1 The Influence of Stringency and Enforcement of Environmental Regulation

Because our measure of a country's quality of environmental regulation rests on both the stringency and enforcement, we also investigate whether our findings are driven by either the stringency or the enforcement of environmental regulation at home, or by both. In Appendix Table 3, we address this issue and separate SEER into its two components: SER (stringency of environmental regulation) and EER (enforcement of environmental regulation). In Panels A and B, we investigate the individual effects of SER and EER on firms' Scope 1 and Scope 2 emissions levels, respectively. Our results show that individually, both the stringency of environmental regulation and the enforcement of this regulation significantly affect emissions levels in the same ways. The results are in line with our main findings reported in Table 3: Firms in countries with more stringent and more strongly enforced environmental regulations emit less in total, less at home but more abroad. The individual effects of SER and EER are economically meaningful: a one-standard-deviation increase in SER (0.56) is associated with an up to 30% decrease in emissions at home and an up to a 37% increase in emissions abroad.[17] Similarly, a one-standard-

[17] From Column (3) in Panel A: $100 * (e^{-0.47 * 0.56} - 1) = -23.14\%$; from Column (3) in Panel B: $100 * (e^{-0.65 * 0.56} - 1) = -30.51\%$; from Column (5) in Panel A: $100 * (e^{0.46 * 0.56} - 1) = 29.38\%$; from Column (5) in Panel B: $100 * (e^{0.57 * 0.56} - 1) = 37.60\%$.

deviation increase in EER (0.68) is associated with an up to 34% decrease in emissions at home and an up to 40% increase in emissions abroad.[18]

In Panels C and D of Appendix Table 3, we go one step further and investigate the simultaneous effects of SER and EER on the emissions levels. To do so, we orthogonalize EER in our regression specifications. The results of this exercise are as follows. Although the stringency of environmental regulations, SER, negatively affects overall and home emissions levels, it positively affects the absolute and relative foreign emissions levels. These results are consistent with our previously documented findings. Similarly, the enforcement of environmental regulation, EER, significantly affects home and foreign emissions levels above and beyond SER with the exception of foreign Scope 2 emissions, which just miss the 10% significance level (Column (3) in Panel D). This finding implies that the enforcement and stringency of environmental regulations are complementary in shaping a firm's pollution behavior.

3.5.2 Addressing Potential Self-Reporting Bias

The underlying information from CDP on emissions is self-reported by firms. This fact raises concerns that our data could have a self-reporting bias. To address this concern, we conduct a subsample analysis similar to our main analysis in Table 3. This time, however, we only include in our sample firms whose CO_2 emissions are externally verified by the firms' auditors. In so doing, we are able to rule out the potential effects of a self-reporting bias on our findings. The drawback of this subsample is that it reduces the sample size by about 40%.

[18] From Column (4) in Panel A: $100 * (e^{-0.45 * 0.68} - 1) = -26.36\%$; from Column (4) in Panel B: $100 * (e^{-0.62 * 0.68} - 1) = -34.40\%$; from Column (6) in Panel A: $100 * (e^{0.44 * 0.68} - 1) = 34.88\%$; from Column (6) in Panel B: $100 * (e^{0.50 * 0.68} - 1) = 40.49\%$.

The findings of this subsample analysis are presented in Appendix Table 4. The results are generally consistent with our main results in Table 3: SEER has a negative effect on the global and home emissions levels and a positive relation with foreign emissions (both absolute and relative). This observation implies that for firms whose reported emissions are externally verified, stricter environmental regulations in the home market lead to lower emissions at home but to higher emissions abroad. The economic effects are similar to those reported in Table 3. For firms with externally verified emissions, a one-standard-deviation (0.90) increase in the strictness of environmental policies is associated with an up to 31% smaller share of home emissions[19] and with an up to 33% greater share of foreign emissions.[20]

4 Conclusion

Pollution is an undesired externality of manufacturing activity that is costly to avoid. As a result, firms are likely to find ways to circumvent costly CO_2 pollution abatement requirements. One of those means could be to transfer manufacturing activities that produce CO_2 to countries where environmental regulations are less stringently defined and enforced than in the firm's home market. As such, the argument goes that countries are also competing in an international marketplace for industrial activity. Therefore, countries with relatively loosely defined and enforced environmental legislation might use this lack of regulation to attract industrial activities, and thus boost GDP and employment statistics. The combination of these demand and supply factors results in the so-called pollution haven hypothesis (PHH), which states that firms move

[19] From Column (2) in Panel A: $100 * (e^{-0.37 * 0.9} - 1) = -28.32\%$; from Column (2) in Panel B: $100 * (e^{-0.41 * 0.9} - 1) = -30.86\%$.
[20] From Column (3) in Panel A: $100 * (e^{0.32 * 0.9} - 1) = 33.38\%$; from Column (3) in Panel B: $100 * (e^{0.28 * 0.9} - 1) = 28.66\%$.

their production activities to countries where environmental regulation causes lower pollution abatement costs, relative to the home country.

Our paper sheds light on this hypothesis using a novel dataset comprising firm-level CO_2 emissions data. We find evidence in favor of the PHH. More specifically, we show that companies indeed shift their CO_2 emitting activities to countries where environmental regulation is less developed and less stringently enforced: Scope 1 and Scope 2 CO_2 emission levels are significantly higher abroad if environmental regulation in the home market is more stringent than abroad. These results hold in a standard firm-level framework as well as in a gravity model context.

Our paper has important implications for firms and countries alike. We document that national regulations can be beneficial: Firms that are highly regulated in their home country pollute less globally. However, we also document that regulatory arbitrage takes place: Firms move their CO_2-intensive activities abroad to countries where environmental regulation is less strict than in the home market. These findings imply that to effectively combat pollution and climate change, national regulation is of only limited effect and concerted action among countries is preferable so that the overall CO_2 balance will not increase. The 2015 Paris Agreement on climate change was an important step toward achieving this goal. If no coordinated effort is undertaken to address climate change, major stakeholders, such as large firms, will find ways to at least partially circumvent strict environmental regulations in certain parts of the world and move their production activities elsewhere.

For multinational firms with production facilities all around the globe, our results imply that — depending on how quickly and effectively countries implement the Paris Agreement — they may continue to benefit from the regulatory arbitrage opportunities we document or they should be prepared to invest in pollution-abatement methods and techniques. Whether the Paris

Agreement will harmonize national environmental regulation to such an extent that firms will no longer have an option to locate operations purely based on concerns about the strictness of environmental regulation in a particular country remains to be seen.

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Table 1. Summary Statistics

The table shows descriptive statistics for all firms that report at least 85% of their global emissions on a country level and that have their headquarters in countries with environmental regulation data. Overall, 1,813 firms from 48 different home countries report Scope 1 emissions, and 1,863 firms from 47 different home countries report Scope 2 emissions. Our proxy for environmental regulation (SEER) combines the World Economic Forum's assessment of a country's stringency and enforcement of environmental regulation. The proxy ranges from 0 to 7, with higher values indicating stricter environmental regulation.

Panel A: Scope 1 Emissions

		Average across firms			
Year	Number of firms	Firm's global emissions in metric tons	Firm's emissions in home country in % of firm's total global emissions	Number of countries in which firm has emissions	Environmental regulation (SEER) in firm's home country
2008	573	5,004,705	71.9	6.0	3.9
2009	792	3,110,120	73.2	6.0	4.0
2010	734	3,119,675	61.4	8.1	4.1
2011	807	3,059,106	61.5	8.2	4.1
2012	855	3,145,869	58.8	8.6	4.2
2013	883	2,990,603	59.1	9.1	4.1
2014	1,030	2,724,609	56.8	9.0	4.2
2015	1,054	2,623,531	56.5	9.0	4.1

Panel B: Scope 2 Emissions

		Average across firms			
Year	Number of firms	Firm's global emissions in metric tons	Firm's emissions in home country in % of firm's total global emissions	Number of countries in which firm has emissions	Environmental regulation (SEER) in firm's home country
2008	543	925,672	69.4	6.8	4.0
2009	812	740,259	69.9	6.9	4.0
2010	756	687,451	58.3	9.5	4.1
2011	834	654,047	57.1	9.9	4.1
2012	901	685,918	53.7	10.2	4.2
2013	918	728,495	53.3	10.7	4.1
2014	1,083	526,509	52.4	10.6	4.1
2015	1,100	521,705	52.6	10.6	4.1

Table 1. Summary Statistics (Cont.)

Panel C: Stringency and Enforcement of Environmental Regulation (SEER)

						Average across… (2008)		
N = 150	Average	Standard deviation	Min	Median	Max	Top 50	Mid 50	Bottom 50
2008	2.300	1.270	0.054	1.940	5.588	3.802	1.955	1.135
2009	2.348	1.323	0.124	1.902	5.761	3.921	1.939	1.175
2010	2.327	1.321	0.223	1.845	6.041	3.860	1.877	1.234
2011	2.344	1.320	0.270	1.940	5.936	3.860	1.915	1.258
2012	2.358	1.296	0.296	1.971	5.853	3.833	1.957	1.276
2013	2.416	1.255	0.520	2.030	5.589	3.827	2.026	1.386
2014	2.465	1.243	0.372	2.150	5.651	3.854	2.036	1.496
2015	2.439	1.225	0.104	2.131	5.560	3.790	2.014	1.506

Table 2. Descriptive Statistics

The table presents descriptive statistics for our CO_2 variables, the stringency and enforcement of the environmental regulation (SEER) variable as well as specific firm-level variables that are used in the empirical analyses that follow.

Panel A: Sample of Firm-Level Observations

	N	Mean	Standard deviation	Min	p10	p25	p50	p75	p90	Max
Scope 1 CO_2 emissions										
Global emissions ('000 tons)	6,325	3,149.84	13,693.48	0.00	2.42	12.58	88.81	585.23	4,500.00	183,400.00
Home emissions ('000 tons)	6,325	1,846.21	8,813.60	0.00	0.37	3.76	33.89	307.34	2,700.00	180,000.00
Foreign emissions ('000 tons)	6,325	1,303.63	8,487.66	0.00	0.00	0.95	13.28	148.91	1,151.05	175,571.07
ln(1+Global emissions) (tons)	6,325	11.43	2.92	0.18	7.79	9.44	11.39	13.28	15.32	19.03
ln(1+Home emissions) (tons)	6,325	10.21	3.73	0.00	5.90	8.23	10.43	12.64	14.81	19.01
ln(1+Foreign emissions) (tons)	6,325	8.88	4.41	0.00	0.00	6.86	9.49	11.91	13.96	18.98
Foreign emissions (% of global emissions)	6,325	38.30	34.68	0.00	0.00	4.97	30.23	68.28	94.72	100.00
Scope 2 CO_2 emissions										
Global emissions ('000 tons)	6,530	678.94	2,683.42	0.00	6.91	33.10	136.04	493.02	1,500.27	120,000.00
Home emissions '000 (tons)	6,530	374.62	2,069.16	0.00	0.75	7.75	49.23	241.38	882.79	120,000.00
Foreign emissions ('000 tons)	6,530	304.31	1,541.90	0.00	0.00	2.86	27.43	168.85	594.51	75,300.00
ln(1+Global emissions) (tons)	6,530	11.65	2.14	0.91	8.84	10.41	11.82	13.11	14.22	18.60
ln(1+Home emissions) (tons)	6,530	10.30	3.17	0.00	6.62	8.96	10.80	12.39	13.69	18.60
ln(1+Foreign emissions) (tons)	6,530	9.26	4.05	0.00	0.00	7.96	10.22	12.04	13.30	18.14
Foreign emissions (% of global emissions)	6,530	42.83	35.78	0.00	0.00	7.51	37.52	77.53	96.58	100.00
Environmental regulation in firm's home country										
SEER (0-7)	7,016	4.11	0.90	1.07	2.81	3.78	4.00	4.86	5.31	6.04
SER (0-7)	7,016	5.43	0.56	2.90	4.68	5.20	5.38	5.91	6.13	6.63
EER (0-7)	7,016	5.23	0.68	2.58	4.20	5.07	5.23	5.76	6.05	6.41
Firm characteristics										
Assets ($m)	7,016	60.70	194.00	0.31	1.33	3.34	8.83	27.30	103.97	1,485.05
ln(assets) ($m)	7,016	2.33	1.71	-2.12	0.29	1.21	2.18	3.31	4.64	6.87
Foreign asset share (%)	5,417	26.40	26.15	0.00	0.00	4.41	17.54	43.71	66.73	98.77
Corporate governance (0-100)	6,086	65.07	28.11	1.55	15.77	45.02	76.53	87.77	92.78	97.67
Home country characteristics										
GDP ($bn)	7,016	5,384.21	6,106.45	19.56	386.40	1,055.00	2,646.00	6,157.00	16,160.00	18,040.00
ln(GDP) ($m)	7,016	14.75	1.33	9.88	12.86	13.87	14.79	15.63	16.60	16.71
GDP per capita growth (%)	7,016	0.64	2.43	-9.00	-2.91	-0.02	0.93	1.68	2.30	25.56

Table 2. Descriptive Statistics (Cont.)

Panel B: Sample of Firm-Country-Level Observations Used in Gravity Analysis

	N	Mean	Standard deviation	Min	p10	p25	p50	p75	p90	Max
Scope 1 CO_2 emissions										
Foreign CO_2 emissions ('000 tons)	671,717	8.75	319.98	0.00	0.00	0.00	0.00	0.00	0.00	66,000.00
ln(1+Foreign CO_2 emissions) (tons)	671,717	0.37	1.75	0.00	0.00	0.00	0.00	0.00	0.00	18.01
Foreign CO_2 emissions (% of global emissions)	671,717	0.27	2.90	0.00	0.00	0.00	0.00	0.00	0.00	100.00
Scope 2 CO_2 emissions										
Foreign CO_2 emissions ('000 tons)	689,448	2.23	70.23	0.00	0.00	0.00	0.00	0.00	0.00	14,000.00
ln(1+Foreign CO_2 emissions) (tons)	689,448	0.44	1.85	0.00	0.00	0.00	0.00	0.00	0.00	16.45
Foreign CO_2 emissions (% of global emissions)	689,448	0.31	3.15	0.00	0.00	0.00	0.00	0.00	0.00	100.00
Environmental regulation										
$SEER_{home}$ - $SEER_{foreign}$	744,782	1.80	1.52	-4.26	-0.42	0.88	2.04	2.84	3.60	5.67
Firm characteristics										
Assets ($m)	744,782	51.05	146.77	0.12	1.35	3.34	8.79	26.94	89.42	960.47
ln(Assets) ($m)	744,782	2.32	1.66	-2.12	0.30	1.21	2.17	3.29	4.49	6.87
Foreign asset share (%)	744,782	26.46	26.14	0.00	0.00	4.34	17.81	44.04	66.63	98.77
Foreign country characteristics										
GDP ($bn)	744,782	462.94	1,519.03	0.69	6.20	13.97	52.91	292.70	926.60	18,039.99
ln(GDP) ($m)	744,782	11.13	1.98	6.54	8.73	9.54	10.88	12.59	13.74	16.71
Country pair characteristics										
Geographic distance (km)	744,782	8,196.11	4,090.00	141.00	2,262.00	5,136.00	8,403.00	10,798.00	13,826.00	19,885.00
ln(Geographic distance) (km)	744,782	8.82	0.73	4.95	7.72	8.54	9.04	9.29	9.53	9.90
Common border (0/1)	744,782	0.01	0.12	0.00	0.00	0.00	0.00	0.00	0.00	1.00
Common colonial history (0/1)	744,782	0.05	0.22	0.00	0.00	0.00	0.00	0.00	0.00	1.00
Trade ($bn)	744,782	11.40	47.28	0.00	0.02	0.09	0.66	4.72	22.54	660.22
ln(Trade) ($)	744,782	20.21	2.82	5.75	16.54	18.29	20.31	22.28	23.84	27.22

Table 3. Analysis of Firm-Level Emissions

The table presents evidence about the relation between emissions in foreign countries and home-country environmental policies. Panels A and B show Scope 1 and 2 emissions, respectively. Columns (1) and (2) are estimated with ordinary least squares, and Columns (3) to (8) are estimated using a Tobit model. Standard errors are clustered by firm. SEER is our proxy for stringency and enforcement of environmental regulation in the firm's home country, with higher values indicating stricter regulation. For each independent variable, the top row shows the estimated coefficient and the bottom row shows the *t*-statistic. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Scope 1 Emissions

Dependent variable:	ln(1+Global emissions (tons))		ln(1+Home emissions (tons))		ln(1+Foreign emissions (tons))		Foreign emissions in % of global emissions	
Specification:	OLS	OLS	Tobit	Tobit	Tobit	Tobit	Tobit	Tobit
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
SEER	-0.18 ***	-0.15 ***	-0.38 ***	-0.30 ***	0.40 ***	0.28 **	4.54 ***	3.31 ***
	(-3.56)	(-2.66)	(-4.21)	(-2.82)	(3.84)	(2.47)	(4.06)	(2.81)
Firm characteristics								
ln(Assets)	1.03 ***	1.05 ***	1.00 ***	1.07 ***	1.43 ***	1.30 ***	3.83 ***	1.82 **
	(28.03)	(27.01)	(15.79)	(15.87)	(19.33)	(18.16)	(4.94)	(2.51)
Foreign asset share		0.00		-0.03 ***		0.04 ***		0.62 ***
		(0.34)		(-7.30)		(11.87)		(16.71)
Home country characteristics								
ln(GDP)	0.03	0.01	0.44 ***	0.32 ***	-0.43 ***	-0.19 **	-8.38 ***	-5.16 ***
	(0.76)	(0.30)	(6.24)	(3.97)	(-5.86)	(-2.50)	(-10.90)	(-6.36)
GDP per capita growth	0.01	0.00	0.05	0.03	-0.20 ***	-0.15 ***	-1.77 ***	-1.23 ***
	(0.77)	(0.28)	(1.60)	(0.80)	(-4.86)	(-3.73)	(-4.33)	(-3.20)
Fixed effects								
Year	yes	yes	yes	yes	yes	yes	yes	yes
Industry	yes	yes	yes	yes	yes	yes	yes	yes
Adjusted/Pseudo R-squared	0.703	0.692	0.108	0.112	0.091	0.104	0.030	0.052
Observations	6,325	4,919	6,325	4,919	6,325	4,919	6,325	4,919
of which censored at 0			274	226	719	481	719	481
of which censored at 100							274	226

Table 3. Analysis of Firm-Level Emissions (Cont.)

Panel B: Scope 2 Emissions

Dependent variable:	ln(1+Global emissions (tons))		ln(1+Home emissions (tons))		ln(1+Foreign emissions (tons))		Foreign emissions in % of global emissions	
Specification:	OLS	OLS	Tobit	Tobit	Tobit	Tobit	Tobit	Tobit
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
SEER	-0.20 ***	-0.18 ***	-0.48 ***	-0.42 ***	0.41 ***	0.34 ***	7.38 ***	6.67 ***
	(-5.07)	(-4.19)	(-5.72)	(-4.29)	(4.25)	(3.47)	(6.90)	(5.97)
Firm characteristics								
ln(Assets)	0.92 ***	0.93 ***	0.80 ***	0.87 ***	1.31 ***	1.21 ***	4.36 ***	2.53 ***
	(29.81)	(27.96)	(14.33)	(14.47)	(19.79)	(19.16)	(5.96)	(3.73)
Foreign asset share		-0.00		-0.03 ***		0.04 ***		0.61 ***
		(-1.41)		(-8.16)		(11.20)		(17.79)
Home country characteristics								
ln(GDP)	0.08 ***	0.06 **	0.52 ***	0.40 ***	-0.29 ***	-0.11 *	-8.50 ***	-5.40 ***
	(2.76)	(2.05)	(7.88)	(5.50)	(-4.50)	(-1.71)	(-11.25)	(-6.90)
GDP per capita growth	0.02	0.01	0.05	0.02	-0.21 ***	-0.14 ***	-1.87 ***	-1.13 ***
	(1.32)	(0.65)	(1.64)	(0.74)	(-5.11)	(-3.64)	(-4.44)	(-3.04)
Fixed effects								
Year	yes	yes	yes	yes	yes	yes	yes	yes
Industry	yes	yes	yes	yes	yes	yes	yes	yes
Adjusted/Pseudo R-squared	0.588	0.594	0.073	0.083	0.082	0.099	0.033	0.054
Observations	6,530	5,018	6,530	5,018	6,530	5,018	6,530	5,018
of which censored at 0			230	196	693	430	693	430
of which censored at 100							231	196

Table 4. Environmental Regulation and Firms' Corporate Governance

The table shows results estimated using ordinary least squares (Column 1) and Tobit (Columns 2–4) regressions with standard errors clustered by firm. For each independent variable, the top row shows the estimated coefficient and the bottom row shows the *t*-statistic. The *F*-test assesses the joint significance of the coefficients of SEER and its interaction effect. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Scope 1 Emissions

Dependent variable:	ln(1+Global emissions (tons))	ln(1+Home emissions (tons))	ln(1+Foreign emissions (tons))	Foreign emissions in % of global emissions
Specification:	OLS	Tobit	Tobit	Tobit
	(1)	(2)	(3)	(4)
SEER	-0.14 **	-0.22 *	0.41 ***	3.45 **
	(-2.11)	(-1.94)	(2.76)	(2.47)
SEER*I(Good governance)	0.00	-0.69 **	-0.36 *	4.67 *
	(0.01)	(-2.46)	(-1.68)	(1.90)
Firm characteristics				
ln(Assets)	1.03 ***	1.07 ***	1.23 ***	1.56 **
	(23.20)	(14.33)	(15.28)	(2.02)
Foreign asset share	0.00	-0.03 ***	0.04 ***	0.61 ***
	(0.71)	(-6.82)	(10.77)	(15.46)
Good governance$_D$	0.09	2.54 **	2.26 **	-10.07
	(0.18)	(2.23)	(2.45)	(-0.99)
Home country characteristics				
ln(GDP)	0.01	0.37 ***	-0.29 ***	-6.19 ***
	(0.32)	(4.05)	(-3.61)	(-7.29)
GDP per capita growth	0.00	0.02	-0.12 ***	-0.91 **
	(0.10)	(0.54)	(-3.22)	(-2.39)
Fixed effects				
Year	yes	yes	yes	yes
Industry	yes	yes	yes	yes
Adjusted/Pseudo R-squared	0.692	0.113	0.106	0.055
F-test	1.54	10.17 ***	0.08	12.04 ***
Observations	4,376	4,376	4,376	4,376
of which censored at 0		196	406	406
of which censored at 100				196

Table 4. Environmental Regulation and Firms' Corporate Governance (Cont.)
Panel B: Scope 2 Emissions

Dependent variable:	ln(1+Global emissions (tons))	ln(1+Home emissions (tons))	ln(1+Foreign emissions (tons))	Foreign emissions in % of global emissions
Specification:	OLS	Tobit	Tobit	Tobit
	(1)	(2)	(3)	(4)
SEER	-0.16 ***	-0.37 ***	0.39 ***	6.53 ***
	(-3.05)	(-3.69)	(3.03)	(4.95)
SEER*I(Good governance)	-0.03	-0.53 *	-0.22	4.33 *
	(-0.34)	(-1.73)	(-1.21)	(1.71)
Firm characteristics				
ln(Assets)	0.91 ***	0.81 ***	1.16 ***	2.75 ***
	(24.33)	(12.44)	(15.88)	(3.72)
Foreign asset share	-0.00 **	-0.03 ***	0.04 ***	0.60 ***
	(-1.99)	(-7.58)	(9.75)	(15.96)
Good governance$_D$	0.14	1.82	1.44 *	-11.99
	(0.36)	(1.45)	(1.75)	(-1.11)
Home country characteristics				
ln(GDP)	0.05	0.45 ***	-0.19 **	-6.14 ***
	(1.39)	(5.16)	(-2.56)	(-7.26)
GDP per capita growth	0.01	0.03	-0.11 ***	-1.00 ***
	(0.87)	(0.73)	(-3.06)	(-2.63)
Fixed effects				
Year	yes	yes	yes	yes
Industry	yes	yes	yes	yes
Adjusted/Pseudo R-squared	0.582	0.083	0.098	0.056
F-test	5.21 **	9.07 ***	1.27	21.61 ***
Observations	4,442	4,442	4,442	4,442
of which censored at 0		159	353	353
of which censored at 100				159

Table 5. Environmental Regulation and Pollution-Intensive Industries

The table shows results estimated as ordinary least squares (Column 1) and Tobit (Columns 2–4) regressions with standard errors clustered by firm. For each independent variable, the top row shows the estimated coefficient and the bottom row shows the *t*-statistic. The *F*-test assesses the joint significance of the coefficients of SEER and its interaction effect. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Scope 1 Emissions

Dependent variable:	ln(1+Global emissions (tons))	ln(1+Home emissions (tons))	ln(1+Foreign emissions (tons))	Foreign emissions in % of global emissions
Specification:	OLS	Tobit	Tobit	Tobit
	(1)	(2)	(3)	(4)
SEER	-0.20 ***	-0.37 ***	0.24 **	3.76 ***
	(-3.38)	(-3.26)	(2.05)	(2.93)
SEER*I(Pollution intensive)	0.30 ***	0.28 **	0.24 **	-0.11
	(5.01)	(2.53)	(1.98)	(-0.09)
Firm characteristics				
ln(Assets)	1.02 ***	1.02 ***	1.26 ***	1.99 **
	(26.13)	(14.06)	(17.27)	(2.57)
Foreign asset share	0.00	-0.03 ***	0.04 ***	0.61 ***
	(0.16)	(-7.37)	(10.89)	(15.86)
Home country characteristics				
ln(GDP)	0.03	0.36 ***	-0.14 *	-5.15 ***
	(0.64)	(4.27)	(-1.80)	(-5.99)
GDP per capita growth	0.01	0.03	-0.13 ***	-1.05 ***
	(0.90)	(0.85)	(-3.20)	(-2.69)
Fixed effects				
Year	yes	yes	yes	yes
Industry	yes	yes	yes	yes
Adjusted/Pseudo R-squared	0.676	0.102	0.108	0.050
F-test	1.59	0.32	8.54 ***	4.27 **
Observations	4,559	4,559	4,559	4,559
of which censored at 0		216	431	431
of which censored at 100				216

Table 5. Environmental Regulation and Pollution-Intensive Industries (Cont.)

Panel B: Scope 2 Emissions

Dependent variable:	ln(1+Global emissions (tons))	ln(1+Home emissions (tons))	ln(1+Foreign emissions (tons))	Foreign emissions in % of global emissions
Specification:	OLS	Tobit	Tobit	Tobit
	(1)	(2)	(3)	(4)
SEER	-0.23 ***	-0.51 ***	0.30 ***	7.03 ***
	(-5.01)	(-4.95)	(2.99)	(5.91)
SEER*I(Pollution intensive)	0.12 **	0.11	0.21 **	0.39
	(2.54)	(1.26)	(2.14)	(0.38)
Firm characteristics				
ln(Assets)	0.93 ***	0.84 ***	1.21 ***	2.98 ***
	(27.67)	(13.28)	(18.95)	(4.23)
Foreign asset share	-0.00 *	-0.03 ***	0.03 ***	0.59 ***
	(-1.77)	(-8.01)	(10.30)	(16.93)
Home country characteristics				
ln(GDP)	0.08 **	0.43 ***	-0.06	-5.40 ***
	(2.52)	(5.83)	(-0.95)	(-6.66)
GDP per capita growth	0.02	0.04	-0.11 ***	-1.09 ***
	(1.33)	(1.13)	(-3.08)	(-2.87)
Fixed effects				
Year	yes	yes	yes	yes
Industry	yes	yes	yes	yes
Adjusted/Pseudo R-squared	0.601	0.085	0.098	0.052
F-test	2.82 *	8.96 ***	14.01 ***	23.04 ***
Observations	4,724	4,724	4,724	4,724
of which censored at 0		184	380	380
of which censored at 100				184

Table 6. Gravity Model

The table shows gravity model results estimated as Tobit regressions with standard errors clustered by country-pair. $SEER_{diff}$ is our proxy for stringency and enforcement of environmental regulation in the home minus the foreign country, with higher values indicating stricter regulation at home. For each independent variable, the top row shows the estimated coefficient and the bottom row shows the *t*-statistic. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable:	Scope 1 emissions		Scope 2 emissions	
	ln(1+Foreign emissions (tons))	Foreign emissions in % of global emissions	ln(1+Foreign emissions (tons))	Foreign emissions in % of global emissions
Specification:	Tobit	Tobit	Tobit	Tobit
	(1)	(2)	(3)	(4)
$SEER_{home}$ - $SEER_{foreign}$	0.40 ***	0.52 ***	0.38 ***	0.39 **
	(2.93)	(2.93)	(3.00)	(2.44)
Controls - firm characteristics				
ln(Assets)	2.38 ***	2.29 ***	1.96 ***	1.88 ***
	(32.79)	(16.92)	(31.20)	(14.27)
Foreign asset share	0.05 ***	0.07 ***	0.04 ***	0.05 ***
	(16.82)	(11.79)	(14.02)	(9.58)
Controls - foreign country characteristics				
ln(GDP)	-0.51	-0.67	0.49	0.61
	(-1.38)	(-1.39)	(1.44)	(1.30)
Gravity controls - country pair characteristics				
ln(Geographic distance)	-1.67 ***	-2.16 ***	-1.33 ***	-1.83 ***
	(-5.49)	(-4.99)	(-4.99)	(-4.41)
Common border	0.80	2.18 *	0.67	1.75
	(1.14)	(1.86)	(1.06)	(1.44)
Common colonial history	3.04 ***	4.42 ***	2.97 ***	4.46 ***
	(6.38)	(6.38)	(7.42)	(6.60)
ln(Trade)	1.93 ***	2.52 ***	1.86 ***	2.44 ***
	(10.02)	(8.53)	(10.72)	(8.93)
Fixed effects				
Year	yes	yes	yes	yes
Industry	yes	yes	yes	yes
Foreign country	yes	yes	yes	yes
Home country	yes	yes	yes	yes
Pseudo R-squared	0.198	0.178	0.203	0.183
Observations	671,717	671,717	689,448	689,448
of which censored at 0	636,406	636,406	645,856	645,856
of which uncensored	35,311	35,296	43,592	43,573
of which censored at 100		15		19

Appendix Table 1. Variable Definitions and Sources

Panel A: Variables used in firm-level analysis

Variable	Description	Units	Original Data Source
Dependent variables			
Global emissions (tons)	firm i's CO_2 emissions globally in year t, calculated for either scope 1 or scope 2 emissions	tons	CDP
Home emissions (tons)	firm i's CO_2 emissions in home country in year t, calculated for either scope 1 or scope 2 emissions	tons	CDP
Foreign emissions (tons)	firm i's CO_2 emissions in all foreign countries combined in year t, calculated for either scope 1 or scope 2 emissions	tons	CDP
Foreign emissions in % of global emissions	firm i's CO_2 emissions in all foreign countries combined in year t in percent of firm i's global CO_2 emissions in year t, calculated for either scope 1 or scope 2 emissions	0-100 with 1.0=1%	CDP
Independent variables			
SER	stringency of environmental regulation in firm i's home country in year t	0-7	World Economic Forum
EER	enforcement of environmental regulation in firm i's home country in year t	0-7	World Economic Forum
SEER	stringency and enforcement of environmental regulation in firm i's home country in year t; calculated as SEER = (SER*EER)/7	0-7	World Economic Forum
Assets	total assets of firm i in year t (WC02999)	US$ million	Worldscope
Foreign asset share	firm i's foreign assets in % of total assets in year t (WC08736)	0-100 with 1.0=1%	Worldscope
Good governance$_D$	dummy equal to 1 if firm i's corporate governance score (CGVSCORE) in year t is larger than the sample median, 0 otherwise	0/1	Asset4
Pollution intensive$_D$	dummy equal to 1 if firm belongs to pollution-intensive industry, 0 otherwise; industries with NACE Industries Codes (Revision 2) C19, C23, C24, D, H50 and H51 are considered to be pollution intensive; the NACE code is mapped to the firm's NAICS code using the Index Correspondent Tables provided by Eurostat, RAMON - Reference And Management of Nomenclatures	0/1	Compustat, Eurostat
External verification$_D$	dummy equal to 1 if firm i's emissions in year t are externally verified, 0 otherwise	0/1	CDP
GDP	gross domestic product in firm i's home country in year t	current US$ million	World Bank's World Development Indicators
GDP per capita growth	annual percentage growth rate of GDP per capita for firm i's home country in year t	0-100 with 1.0=1%	World Bank's World Development Indicators

Appendix Table 1. Variable Definitions and Sources (Cont.)

Panel B: Variables used in gravity analysis

Variable	Description	Units	Original Data Source
Dependent variables			
Foreign emissions (tons)	firm i's CO_2 emissions in foreign country c in year t, calculated for either scope 1 or scope 2 emissions	tons	CDP
Foreign emissions in % of global emissions	firm i's CO_2 emissions in foreign country c in year t in percent of firm i's global CO_2 emissions in year t, calculated for either scope 1 or scope 2 emissions	0-100 with 1.0=1%	CDP
Independent variables			
$SEER_{home}$ - $SEER_{foreign}$	difference between stringency and enforcement of environmental regulation in firm i's home country and foreign country c in year t; each country's SEER is calculated as SEER = (SER*EER)/7	-7 to +7	World Economic Forum
Assets	total assets of firm i in year t (WC02999)	US$ million	Worldscope
Foreign asset share	firm i's foreign assets in % of total assets in year t (WC08736)	0-100 with 1.0=1%	Worldscope
GDP	gross domestic product in foreign country c in year t	current US$ million	World Bank's World Development Indicators
Geographic distance	geographic distance between firm i's home country and foreign country c, measured using the great circle distance formula	km	www.distancefromto.net
Common border	dummy equal to 1 if firm I's home country and the foreign country c share a land border, 0 otherwise	0/1	Glick and Rose (2016), CIA World Factbook
Common colonial history	dummy equal to 1 if firm i's home country and foreign country c have a colonial history or belonged to same country	0/1	Glick and Rose (2016)
Trade	sum of exports and imports between firm i's home country and foreign country c in year t	US$	IMF's Direction of Trade Statistics

Panel C: Fixed effects used in firm-level and gravity analyses

Variable	Description	Units	Original Data Source
Year	dummies identifying the year t in which firm i emits CO_2, 2008-2016	0/1	CDP
Industry	dummies based on 2-digit SIC codes (WC07021)	0/1	Worldscope
Foreign country	dummies identifying the foreign country c in which firm i emits CO_2	0/1	CDP
Home country	dummies identifying the home country in which firm i is headquartered	0/1	CDP

Appendix Table 2. Pollution-Intensive Industries

The table presents summary statistics about the pollution intensity of industries and firms in pollution-intensive versus non-pollution-intensive industries. Panel A shows the CO_2 intensity of various industries in the European Union (2018 member states). CO_2 intensity is measured as the kilograms of CO_2 per Euro of gross value added. For comparability over time, gross value added is measured in real terms (chain linked volumes at 2010 prices) to eliminate the effects of inflation. Pollution-intensive industries are marked with an asterisk and bold face. Source: Eurostat, Air emission accounts, Air emissions intensities by NACE Rev. 2 activity (env_ac_aeint_r2): http://ec.europa.eu/eurostat/web/environment/emissions-of-greenhouse-gases-and-air-pollutants/air-emission-accounts/database. Panel B presents summary statistics for all firms that could be mapped into the NACE industries. Panel C presents summary statistics for the firms classified as not having material polluting activities. Panel D presents summary statistics for the firms classified as having material polluting activities.

Panel A: Industry CO_2 Emission Intensity (kg per Euro), by Year

NACE Industry Code (Revision 2)	2008	2009	2010	2011	2012	2013	2014	2015
TOTAL - Total - all NACE activities	0.30	0.28	0.28	0.27	0.27	0.26	0.24	0.24
A - Agriculture, forestry and fishing	0.55	0.54	0.57	0.55	0.58	0.56	0.53	0.52
A01 - Crop and animal production, hunting and related service activities	0.56	0.55	0.59	0.57	0.60	0.58	0.55	0.54
A02 - Forestry and logging	0.22	0.21	0.22	0.20	0.19	0.19	0.17	0.18
A03 - Fishing and aquaculture	1.27	1.23	1.19	1.24	1.23	1.21	1.11	1.11
B - Mining and quarrying	0.54	0.54	0.53	0.55	0.51	0.52	0.53	0.53
C - Manufacturing	0.54	0.53	0.51	0.48	0.47	0.45	0.44	0.42
C10-C12 - Manufacture of food products; beverages and tobacco products	0.28	0.26	0.26	0.24	0.25	0.24	0.23	0.21
C13-C15 - Manufacture of textiles, wearing apparel, leather and related products	0.16	0.16	0.15	0.14	0.14	0.14	0.13	0.14
C16 - Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	0.22	0.20	0.19	0.17	0.17	0.17	0.16	0.15
C17 - Manufacture of paper and paper products	0.86	0.83	0.83	0.80	0.74	0.74	0.69	0.70
C18 - Printing and reproduction of recorded media	0.09	0.08	0.09	0.08	0.08	0.09	0.08	0.09
C19 - Manufacture of coke and refined petroleum products*	**5.91**	**5.26**	**5.80**	**5.84**	**7.34**	**5.93**	**5.36**	**3.59**
C20 - Manufacture of chemicals and chemical products	1.32	1.30	1.26	1.23	1.23	1.20	1.12	1.04
C21 - Manufacture of basic pharmaceutical products and pharmaceutical preparations	0.07	0.06	0.06	0.06	0.06	0.06	0.05	0.05
C22 - Manufacture of rubber and plastic products	0.17	0.15	0.16	0.13	0.13	0.15	0.14	0.14
C23 - Manufacture of other non-metallic mineral products*	**3.36**	**3.31**	**3.27**	**3.09**	**3.03**	**2.97**	**2.92**	**2.92**
C24 - Manufacture of basic metals*	**3.23**	**2.90**	**3.08**	**2.86**	**2.55**	**2.43**	**2.31**	**2.21**
C25 - Manufacture of fabricated metal products, except machinery and equipment	0.09	0.11	0.10	0.09	0.09	0.09	0.08	0.09
C26 - Manufacture of computer, electronic and optical products	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.03
C27 - Manufacture of electrical equipment	0.05	0.06	0.05	0.05	0.05	0.05	0.05	0.05
C28 - Manufacture of machinery and equipment n.e.c.	0.05	0.06	0.05	0.05	0.04	0.05	0.04	0.04
C29 - Manufacture of motor vehicles, trailers and semi-trailers	0.07	0.08	0.07	0.06	0.06	0.06	0.05	0.05
C30 - Manufacture of other transport equipment	0.06	0.06	0.06	0.05	0.04	0.04	0.04	0.04
C31+C32 - Manufacture of furniture; other manufacturing	0.08	0.07	0.07	0.06	0.06	0.06	0.06	0.06
C33 - Repair and installation of machinery and equipment	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
D - Electricity, gas, steam and air conditioning supply*	**6.29**	**5.69**	**5.70**	**5.91**	**5.63**	**5.56**	**5.26**	**5.24**
E - Water supply; sewerage, waste management and remediation activities	0.37	0.36	0.37	0.35	0.34	0.35	0.35	0.34
E36 - Water collection, treatment and supply	0.22	0.21	0.19	0.17	0.17	0.18	0.18	0.18
E37-E39 - Sewerage, waste management, remediation activities	0.43	0.42	0.43	0.41	0.41	0.41	0.41	0.40
F - Construction	0.08	0.08	0.09	0.09	0.09	0.09	0.09	0.09
G - Wholesale and retail trade; repair of motor vehicles and motorcycles	0.06	0.06	0.06	0.06	0.06	0.06	0.05	0.05
G45 - Wholesale and retail trade and repair of motor vehicles and motorcycles	0.07	0.07	0.07	0.06	0.06	0.06	0.06	0.06
G46 - Wholesale trade, except of motor vehicles and motorcycles	0.06	0.06	0.06	0.06	0.06	0.05	0.05	0.05
G47 - Retail trade, except of motor vehicles and motorcycles	0.06	0.06	0.06	0.06	0.06	0.06	0.05	0.05
H - Transportation and storage	0.90	0.88	0.87	0.85	0.83	0.82	0.81	0.83
H49 - Land transport and transport via pipelines	0.79	0.78	0.78	0.75	0.72	0.73	0.72	0.72
H50 - Water transport*	**3.37**	**3.39**	**3.40**	**3.43**	**3.26**	**3.01**	**3.25**	**3.66**
H51 - Air transport*	**4.10**	**4.47**	**3.93**	**3.88**	**3.74**	**3.70**	**4.10**	**4.35**
H52 - Warehousing and support activities for transportation	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
H53 - Postal and courier activities	0.11	0.11	0.12	0.11	0.11	0.12	0.12	0.13

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Appendix Table 2. Pollution-Intensive Industries (Cont.)

(continues from previous page)

NACE Industry Code (Revision 2)	2008	2009	2010	2011	2012	2013	2014	2015
I - Accommodation and food service activities	0.06	0.06	0.07	0.06	0.06	0.06	0.05	0.05
J - Information and communication	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01
J58 - Publishing activities	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02
J59+J60 - Motion picture, video, television programme production; programming and b	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02
J61 - Telecommunications	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01
J62+J63 - Computer programming, consultancy, and information service activities	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01
K - Financial and insurance activities	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
K64 - Financial service activities, except insurance and pension funding	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
K65 - Insurance, reinsurance and pension funding, except compulsory social security	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
K66 - Activities auxiliary to financial services and insurance activities	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01
L - Real estate activities	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
M - Professional, scientific and technical activities								
M69+M70 - Legal and accounting activities; activities of head offices; management consultancy activities	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02
M71 - Architectural and engineering activities; technical testing and analysis	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02
M72 - Scientific research and development	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04
M73 - Advertising and market research	0.03	0.04	0.03	0.03	0.03	0.03	0.02	0.02
M74+M75 - Other professional, scientific and technical activities; veterinary activities	0.03	0.04	0.03	0.03	0.03	0.03	0.03	0.03
N - Administrative and support service activities	0.05	0.05	0.05	0.05	0.05	0.05	0.04	0.04
N77 - Rental and leasing activities	0.10	0.10	0.09	0.09	0.09	0.09	0.08	0.08
N78 - Employment activities	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
N79 - Travel agency, tour operator reservation service and related activities	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03
N80-N82 - Security and investigation, service and landscape, office administrative and support activities	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03
O - Public administration and defence; compulsory social security	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04
P - Education	0.04	0.03	0.04	0.03	0.03	0.03	0.03	0.03
Q - Human health and social work activities								
Q86 - Human health activities	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Q87+Q88 - Residential care activities and social work activities without accommodation	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.04
R - Arts, entertainment and recreation	0.05	0.05	0.05	0.05	0.05	0.05	0.04	0.04
R90-R92 - Creative, arts and entertainment activities; libraries, archives, museums and other cultural activities; gambling and betting activities	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03
R93 - Sports activities and amusement and recreation activities	0.07	0.07	0.07	0.07	0.07	0.07	0.06	0.06
S - Other service activities	0.06	0.05	0.05	0.05	0.05	0.05	0.04	0.05
S94 - Activities of membership organisations	0.05	0.05	0.05	0.04	0.04	0.05	0.04	0.04
S95 - Repair of computers and personal and household goods	0.06	0.06	0.07	0.06	0.06	0.06	0.06	0.06
S96 - Other personal service activities	0.06	0.05	0.05	0.05	0.05	0.05	0.04	0.04

Appendix Table 2. Pollution-Intensive Industries (Cont.)

Panel B: All Firms (that could be mapped into polluting and nonpolluting industries)

	N	Mean	Standard deviation	Min	p10	p25	p50	p75	p90	Max
Scope 1 CO_2 emissions										
Global emissions ('000 tons)	4,559	1,731	8,643	0	3	12	77	444	2,804	176,000
Home emissions '000 (tons)	4,559	821	3,602	0	0	3	29	235	1,395	61,000
Foreign emissions ('000 tons)	4,559	910	7,509	0	0	1	14	137	845	175,571
ln(1+Global emissions) (tons)	4,559	11.26	2.69	0.69	7.88	9.41	11.25	13.00	14.85	18.99
ln(1+Home emissions) (tons)	4,559	9.95	3.58	0.00	5.75	8.15	10.28	12.37	14.15	17.93
ln(1+Foreign emissions) (tons)	4,559	9.02	4.11	0.00	1.31	7.22	9.57	11.83	13.65	18.98
Foreign emissions (% of global emissions)	4,559	40.11	34.67	0.00	0.02	7.02	32.94	70.93	95.53	100.00
Scope 2 CO_2 emissions										
Global emissions ('000 tons)	4,724	686	2,788	0	8	35	140	481	1,513	120,000
Home emissions '000 (tons)	4,724	373	2,333	0	1	8	48	234	841	120,000
Foreign emissions ('000 tons)	4,724	313	1,352	0	0	5	34	175	600	25,500
ln(1+Global emissions) (tons)	4,724	11.69	2.07	0.91	8.94	10.47	11.85	13.08	14.23	18.60
ln(1+Home emissions) (tons)	4,724	10.28	3.17	0.00	6.72	8.93	10.77	12.36	13.64	18.60
ln(1+Foreign emissions) (tons)	4,724	9.62	3.72	0.00	4.28	8.45	10.43	12.07	13.30	17.05
Foreign emissions (% of global emissions)	4,724	44.96	35.17	0.00	0.25	10.85	41.71	79.10	96.78	100.00
Environmental regulation in firm's home country										
SEER (0-7)	5,039	4.15	0.85	1.49	2.99	3.80	4.03	4.86	5.30	6.04
SER (0-7)	5,039	5.45	0.52	3.40	4.85	5.24	5.38	5.87	6.13	6.63
EER (0-7)	5,039	5.27	0.63	3.07	4.40	5.08	5.23	5.73	6.05	6.41
Firm characteristics										
Assets ($m)	5,039	54.83	181.06	0.31	1.31	3.24	8.50	25.25	79.55	1,485.05
ln(assets) ($m)	5,039	2.27	1.66	-2.12	0.27	1.17	2.14	3.23	4.38	6.87
Foreign asset share (%)	5,039	26.55	26.31	0.00	0.00	4.46	17.49	44.04	67.34	98.77
Corporate governance (0-100)	4,458	67.08	27.39	1.83	17.48	50.62	78.44	88.29	93.00	97.61
Home country characteristics										
GDP ($bn)	5,039	5,835	6,382	20	392	1,142	2,720	14,420	16,690	18,040
ln(GDP) ($m)	5,039	14.82	1.36	9.88	12.88	13.95	14.82	16.48	16.63	16.71
GDP per capita growth (%)	5,039	0.73	2.44	-8.71	-1.89	0.09	1.00	1.68	2.30	25.56

Appendix Table 2. Pollution-Intensive Industries (Cont.)

Panel C: Firms in Nonpolluting Industries

	N	Mean	Standard deviation	Min	p10	p25	p50	p75	p90	Max
Scope 1 CO_2 emissions										
Global emissions ('000 tons)	4,263	883	3,501	0	2	11	64	354	1,583	99,000
Home emissions '000 (tons)	4,263	478	1,882	0	0	3	24	170	757	40,000
Foreign emissions ('000 tons)	4,263	406	2,468	0	0	1	12	107	570	94,400
ln(1+Global emissions) (tons)	4,263	11.03	2.55	0.69	7.79	9.31	11.07	12.78	14.27	18.41
ln(1+Home emissions) (tons)	4,263	9.71	3.47	0.00	5.67	8.02	10.09	12.04	13.54	17.50
ln(1+Foreign emissions) (tons)	4,263	8.84	3.97	0.00	1.61	7.13	9.40	11.58	13.25	18.36
Foreign emissions (% of global emissions)	4,263	40.08	34.72	0.00	0.03	7.21	32.48	70.75	95.62	100.00
Scope 2 CO_2 emissions										
Global emissions ('000 tons)	4,405	594	2,731	0	7	33	127	432	1,248	120,000
Home emissions '000 (tons)	4,405	351	2,389	0	1	7	43	210	728	120,000
Foreign emissions ('000 tons)	4,405	244	1,121	0	0	4	31	153	502	25,500
ln(1+Global emissions) (tons)	4,405	11.60	2.02	1.10	8.88	10.40	11.75	12.98	14.04	18.60
ln(1+Home emissions) (tons)	4,405	10.19	3.16	0.00	6.70	8.85	10.66	12.25	13.50	18.60
ln(1+Foreign emissions) (tons)	4,405	9.55	3.63	0.00	4.64	8.39	10.33	11.94	13.13	17.05
Foreign emissions (% of global emissions)	4,405	44.96	35.18	0.00	0.33	10.86	41.60	79.10	96.61	100.00
Environmental regulation in firm's home country										
SEER (0-7)	4,690	4.15	0.84	1.49	3.02	3.80	4.03	4.83	5.30	6.04
SER (0-7)	4,690	5.45	0.52	3.40	4.87	5.24	5.38	5.87	6.13	6.63
EER (0-7)	4,690	5.27	0.62	3.07	4.40	5.08	5.23	5.73	6.05	6.41
Firm characteristics										
Assets ($m)	4,690	56.46	186.62	0.31	1.27	3.14	8.46	25.32	82.51	1,485.05
ln(assets) ($m)	4,690	2.26	1.68	-2.12	0.24	1.14	2.13	3.23	4.41	6.87
Foreign asset share (%)	4,690	26.53	26.47	0.00	0.00	4.37	17.22	44.04	68.12	98.77
Corporate governance (0-100)	4,158	67.33	27.19	1.83	17.76	51.73	78.58	88.26	92.99	97.61
Home country characteristics										
GDP ($bn)	4,690	5,942	6,428	20	396	1,144	2,720	14,420	16,690	18,040
ln(GDP) ($m)	4,690	14.85	1.35	9.88	12.89	13.95	14.82	16.48	16.63	16.71
GDP per capita growth (%)	4,690	0.75	2.43	-8.71	-1.83	0.09	1.06	1.68	2.30	25.56

Appendix Table 2. Pollution-Intensive Industries (Cont.)

Panel D: Firms in Pollution-Intensive Industries

	N	Mean	Standard deviation	Min	p10	p25	p50	p75	p90	Max
Scope 1 CO_2 emissions										
Global emissions ('000 tons)	296	13,941	28,585	0	63	384	3,100	14,076	42,000	176,000
Home emissions '000 (tons)	296	5,763	11,096	0	20	252	1,425	3,959	17,429	61,000
Foreign emissions ('000 tons)	296	8,178	26,955	0	0	22	760	2,984	12,347	175,571
ln(1+Global emissions) (tons)	296	14.56	2.56	2.71	11.06	12.86	14.95	16.46	17.55	18.99
ln(1+Home emissions) (tons)	296	13.36	3.45	0.00	9.89	12.43	14.17	15.19	16.67	17.93
ln(1+Foreign emissions) (tons)	296	11.64	5.15	0.00	0.00	9.98	13.54	14.91	16.33	18.98
Foreign emissions (% of global emissions)	296	40.56	33.99	0.00	0.00	6.16	35.69	71.76	91.16	100.00
Scope 2 CO_2 emissions										
Global emissions ('000 tons)	319	1,949	3,232	0	23	140	625	2,344	5,429	20,000
Home emissions '000 (tons)	319	678	1,296	0	3	39	231	877	1,700	9,700
Foreign emissions ('000 tons)	319	1,271	2,957	0	0	16	157	948	3,463	19,622
ln(1+Global emissions) (tons)	319	12.97	2.34	0.91	10.03	11.85	13.35	14.67	15.51	16.81
ln(1+Home emissions) (tons)	319	11.54	3.15	0.00	7.83	10.56	12.35	13.68	14.35	16.09
ln(1+Foreign emissions) (tons)	319	10.67	4.69	0.00	0.00	9.70	11.97	13.76	15.06	16.79
Foreign emissions (% of global emissions)	319	44.95	35.14	0.00	0.00	10.85	43.33	79.10	98.14	100.00
Environmental regulation in firm's home country										
SEER (0-7)	349	4.18	0.99	1.68	2.54	3.78	4.09	4.96	5.33	5.94
SER (0-7)	349	5.47	0.61	3.46	4.57	5.20	5.41	5.95	6.17	6.49
EER (0-7)	349	5.27	0.77	3.24	3.81	5.08	5.32	5.84	6.08	6.41
Firm characteristics										
Assets ($m)	349	32.90	69.24	0.36	2.14	4.26	9.89	23.99	69.05	393.23
ln(assets) ($m)	349	2.41	1.38	-1.02	0.76	1.45	2.29	3.18	4.23	5.97
Foreign asset share (%)	349	26.82	24.14	0.00	0.00	6.71	20.27	43.83	60.05	98.77
Corporate governance (0-100)	300	63.61	29.90	2.96	14.07	35.20	74.46	88.66	93.28	96.35
Home country characteristics										
GDP ($bn)	349	4,393	5,537	53	273	696	1,789	5,156	15,520	18,040
ln(GDP) ($m)	349	14.46	1.39	10.88	12.52	13.45	14.40	15.46	16.56	16.71
GDP per capita growth (%)	349	0.46	2.47	-8.71	-3.62	-0.48	0.88	1.68	2.38	8.75

Appendix Table 3. SER vs. EER

The table presents evidence about the relation between emissions in foreign countries and home-country stringency and enforcement (SER and EER) or environmental policies. Panels A and C show Scope 1 emissions, and Panels B and D show Scope 2 emissions. Columns (1) and (2) are estimated with ordinary least squares, and Columns (3) to (8) are estimated as a Tobit model. Standard errors are clustered by firm. For each independent variable, the top row shows the estimated coefficient and the bottom row shows the *t*-statistic. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Scope 1 Emissions

Dependent variable:	ln(1+Global emissions (tons))		ln(1+Home emissions (tons))		ln(1+Foreign emissions (tons))		Foreign emissions in % of global emissions	
Specification:	OLS	OLS	Tobit	Tobit	Tobit	Tobit	Tobit	Tobit
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
SER (stringency)	-0.25 ***		-0.47 ***		0.46 **		5.25 ***	
	(-2.71)		(-2.62)		(2.46)		(2.73)	
EER (enforcement)		-0.19 ***		-0.45 ***		0.44 ***		5.44 ***
		(-2.61)		(-3.34)		(2.87)		(3.48)
Firm characteristics								
ln(Assets)	1.05 ***	1.05 ***	1.07 ***	1.07 ***	1.30 ***	1.31 ***	1.82 **	1.84 **
	(27.02)	(26.97)	(15.87)	(15.86)	(18.16)	(18.20)	(2.51)	(2.55)
Foreign asset share	0.00	0.00	-0.03 ***	-0.03 ***	0.04 ***	0.04 ***	0.62 ***	0.62 ***
	(0.33)	(0.37)	(-7.31)	(-7.26)	(11.87)	(11.81)	(16.72)	(16.66)
Home country characteristics								
ln(GDP)	0.01	0.02	0.32 ***	0.34 ***	-0.19 **	-0.20 ***	-5.15 ***	-5.34 ***
	(0.28)	(0.47)	(3.95)	(4.20)	(-2.48)	(-2.71)	(-6.34)	(-6.62)
GDP per capita growth	0.00	0.01	0.03	0.03	-0.15 ***	-0.15 ***	-1.20 ***	-1.22 ***
	(0.16)	(0.36)	(0.73)	(0.79)	(-3.71)	(-3.73)	(-3.15)	(-3.18)
Fixed effects								
Year	yes	yes	yes	yes	yes	yes	yes	yes
Industry	yes	yes	yes	yes	yes	yes	yes	yes
Adjusted/Pseudo R-squared	0.692	0.691	0.112	0.113	0.104	0.105	0.051	0.052
Observations	4,919	4,919	4,919	4,919	4,919	4,919	4,919	4,919
of which censored at 0			226	226	481	481	481	481
of which censored at 100							226	226

Appendix Table 3. SER vs. EER (Cont.)

Panel B: Scope 2 Emissions

Dependent variable:	ln(1+Global emissions (tons))		ln(1+Home emissions (tons))		ln(1+Foreign emissions (tons))		Foreign emissions in % of global emissions	
Specification:	OLS	OLS	Tobit	Tobit	Tobit	Tobit	Tobit	Tobit
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
SER (stringency)	-0.30 ***		-0.65 ***		0.57 ***		10.50 ***	
	(-4.38)		(-3.98)		(3.43)		(5.79)	
EER (enforcement)		-0.23 ***		-0.62 ***		0.50 ***		9.89 ***
		(-3.92)		(-4.73)		(3.80)		(6.58)
Firm characteristics								
ln(Assets)	0.93 ***	0.93 ***	0.87 ***	0.87 ***	1.21 ***	1.21 ***	2.55 ***	2.56 ***
	(27.96)	(27.93)	(14.45)	(14.47)	(19.17)	(19.20)	(3.74)	(3.79)
Foreign asset share	-0.00	-0.00	-0.03 ***	-0.03 ***	0.04 ***	0.04 ***	0.61 ***	0.60 ***
	(-1.42)	(-1.38)	(-8.16)	(-8.10)	(11.20)	(11.12)	(17.78)	(17.70)
Home country characteristics								
ln(GDP)	0.06 **	0.07 **	0.40 ***	0.43 ***	-0.11 *	-0.13 **	-5.38 ***	-5.75 ***
	(2.02)	(2.33)	(5.45)	(5.86)	(-1.69)	(-1.99)	(-6.82)	(-7.48)
GDP per capita growth	0.01	0.01	0.02	0.02	-0.13 ***	-0.14 ***	-1.06 ***	-1.15 ***
	(0.43)	(0.79)	(0.63)	(0.75)	(-3.60)	(-3.67)	(-2.92)	(-3.08)
Fixed effects								
Year	yes	yes	yes	yes	yes	yes	yes	yes
Industry	yes	yes	yes	yes	yes	yes	yes	yes
Adjusted/Pseudo R-squared	0.594	0.594	0.083	0.084	0.099	0.099	0.053	0.054
Observations	5,018	5,018	5,018	5,018	5,018	5,018	5,018	5,018
of which censored at 0			196	196	430	430	430	430
of which censored at 100							196	196

Appendix Table 3. SER vs. EER (Cont.)

Panel C: Orthogonalized Environmental Enforcement; Scope 1 Emissions

Dependent variable:	ln(1+Global emissions (tons))	ln(1+Home emissions (tons))	ln(1+Foreign emissions (tons))	Foreign emissions in % of global emissions
Specification:	OLS	Tobit	Tobit	Tobit
	(1)	(2)	(3)	(4)
SER (stringency)	-0.13 ***	-0.24 **	0.24 **	2.66 ***
	(-2.71)	(-2.55)	(2.38)	(2.62)
EER_o (enforcement; orthogonalized)	0.00	-0.19 **	0.18 **	2.90 ***
	(0.02)	(-2.25)	(2.00)	(3.48)
Firm characteristics				
ln(Assets)	1.05 ***	1.07 ***	1.31 ***	1.85 **
	(27.00)	(15.86)	(18.23)	(2.56)
Foreign asset share	0.00	-0.03 ***	0.04 ***	0.61 ***
	(0.33)	(-7.23)	(11.80)	(16.66)
Home country characteristics				
ln(GDP)	0.01	0.36 ***	-0.22 ***	-5.69 ***
	(0.27)	(4.21)	(-2.86)	(-6.88)
GDP per capita growth	0.00	0.04	-0.15 ***	-1.37 ***
	(0.15)	(1.01)	(-3.90)	(-3.52)
Fixed effects				
Year	yes	yes	yes	yes
Industry	yes	yes	yes	yes
Adjusted/Pseudo R-squared	0.692	0.113	0.105	0.052
Observations	4,919	4,919	4,919	4,919
of which censored at 0		226	481	481
of which censored at 100				226

Appendix Table 3. SER vs. EER (Cont.)

Panel D: Orthogonalized Environmental Enforcement; Scope 2 Emissions

Dependent variable:	ln(1+Global emissions (tons))	ln(1+Home emissions (tons))	ln(1+Foreign emissions (tons))	Foreign emissions in % of global emissions
Specification:	OLS	Tobit	Tobit	Tobit
	(1)	(2)	(3)	(4)
SER (stringency)	-0.16 ***	-0.33 ***	0.30 ***	5.41 ***
	(-4.40)	(-3.92)	(3.37)	(5.74)
EER_o (enforcement; orthogonalized)	0.01	-0.24 **	0.12	3.62 ***
	(0.17)	(-2.53)	(1.61)	(4.06)
Firm characteristics				
ln(Assets)	0.93 ***	0.87 ***	1.21 ***	2.54 ***
	(27.96)	(14.51)	(19.21)	(3.78)
Foreign asset share	-0.00	-0.03 ***	0.04 ***	0.60 ***
	(-1.43)	(-8.11)	(11.11)	(17.68)
Home country characteristics				
ln(GDP)	0.06 *	0.45 ***	-0.13 **	-6.08 ***
	(1.95)	(5.91)	(-1.97)	(-7.74)
GDP per capita growth	0.01	0.03	-0.14 ***	-1.29 ***
	(0.39)	(1.09)	(-3.77)	(-3.46)
Fixed effects				
Year	yes	yes	yes	yes
Industry	yes	yes	yes	yes
Adjusted/Pseudo R-squared	0.594	0.084	0.099	0.055
Observations	5,018	5,018	5,018	5,018
of which censored at 0		196	430	430
of which censored at 100				196

Appendix Table 4. Subsample Analysis – Only Externally Verified Emissions

The table presents evidence about the relation between emissions in foreign countries and home-country environmental policies for companies whose emissions information is externally verified. Panels A and B show Scope 1 and 2 emissions, respectively. Column 1 is estimated with ordinary least squares, and Columns 2 to 4 are estimated as a Tobit model. Standard errors are clustered by firm. SEER is our proxy for stringency and enforcement of environmental regulation in the firm's home country, with higher values indicating stricter regulation. For each independent variable, the top row shows the estimated coefficient and the bottom row shows the *t*-statistic. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Scope 1 Emissions

Dependent variable:	ln(1+Global emissions (tons))	ln(1+Home emissions (tons))	ln(1+Foreign emissions (tons))	Foreign emissions in % of global emissions
Specification:	OLS	Tobit	Tobit	Tobit
	(1)	(2)	(3)	(4)
SEER	-0.16 **	-0.37 ***	0.28 **	3.24 **
	(-2.55)	(-3.28)	(2.34)	(2.55)
Firm characteristics				
ln(Assets)	1.05 ***	1.05 ***	1.30 ***	2.66 ***
	(24.23)	(11.77)	(15.71)	(2.87)
Foreign asset share	0.00 *	-0.03 ***	0.04 ***	0.61 ***
	(1.67)	(-5.35)	(10.98)	(14.02)
Home country characteristics				
ln(GDP)	0.04	0.34 ***	-0.11	-5.01 ***
	(0.83)	(3.90)	(-1.33)	(-5.50)
GDP per capita growth	0.01	0.04	-0.11 ***	-1.24 ***
	(0.77)	(1.12)	(-2.93)	(-2.93)
Fixed effects				
Year	yes	yes	yes	yes
Industry	yes	yes	yes	yes
Adjusted/Pseudo R-squared	0.739	0.125	0.116	0.052
Observations	3,075	3,075	3,075	3,075
of which censored at 0		122	235	235
of which censored at 100				122

Appendix Table 4. Subsample Analysis – Only Externally Verified Emissions (Cont.)

Panel B: Scope 2 Emissions

Dependent variable:	ln(1+Global emissions (tons))	ln(1+Home emissions (tons))	ln(1+Foreign emissions (tons))	Foreign emissions in % of global emissions
Specification:	OLS	Tobit	Tobit	Tobit
	(1)	(2)	(3)	(4)
SEER	-0.15 ***	-0.41 ***	0.32 ***	6.14 ***
	(-3.13)	(-3.70)	(3.03)	(4.90)
Firm characteristics				
ln(Assets)	0.94 ***	0.78 ***	1.23 ***	4.31 ***
	(22.21)	(9.52)	(17.12)	(5.14)
Foreign asset share	-0.00	-0.03 ***	0.04 ***	0.62 ***
	(-1.07)	(-6.44)	(9.25)	(14.67)
Home country characteristics				
ln(GDP)	0.04	0.44 ***	-0.14 *	-5.83 ***
	(1.13)	(4.84)	(-1.92)	(-6.42)
GDP per capita growth	0.01	0.03	-0.12 ***	-1.20 ***
	(0.74)	(0.68)	(-3.16)	(-2.79)
Fixed effects				
Year	yes	yes	yes	yes
Industry	yes	yes	yes	yes
Adjusted/Pseudo R-squared	0.631	0.076	0.115	0.058
Observations	2,895	2,895	2,895	2,895
of which censored at 0		115	168	168
of which censored at 100				115

Figure 1. Global Development of Environmental Regulation

The heat maps show our proxy for environmental regulation (SEER) for the 150 countries included in our sample. SEER combines the World Economic Forum's assessment of a country's stringency and enforcement of environmental regulation. SEER ranges from 0 to 7, with higher values indicating stricter environmental regulation.

Figure 1a. 2008

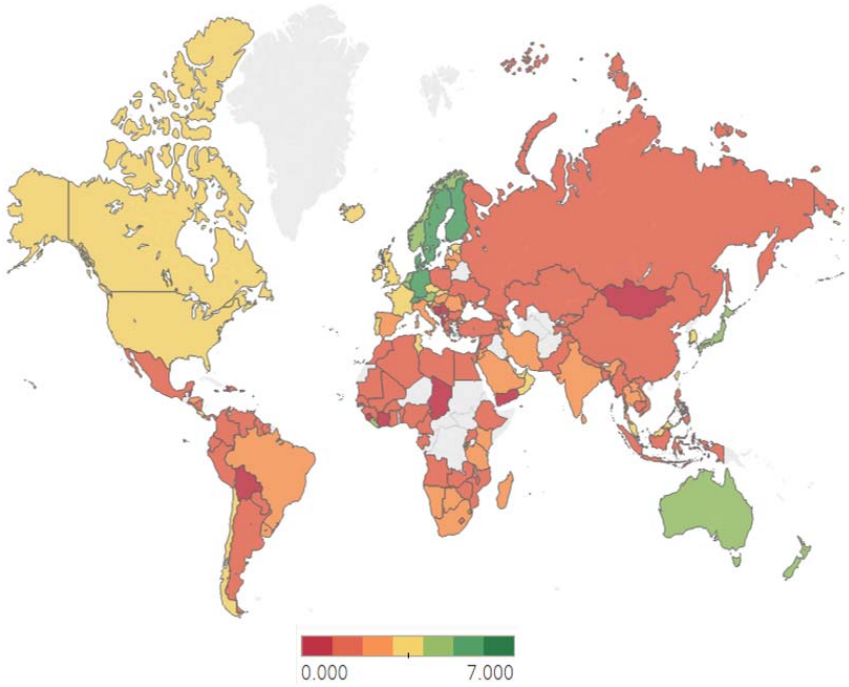

Figure 1b. 2015

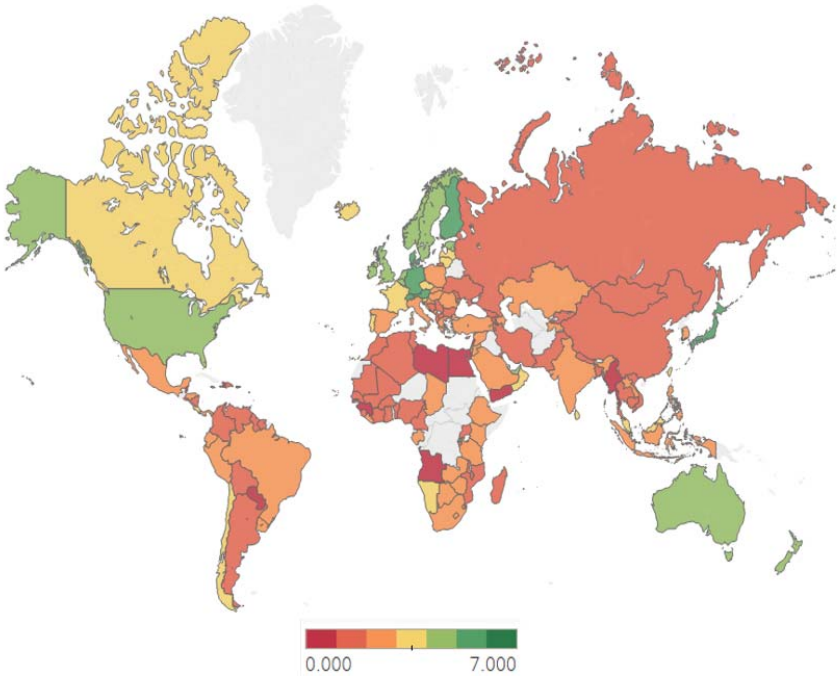

Figure 2. Visualization of the Pollution Haven Hypothesis with Respect to Home-Country Environmental Regulation

The figure visualizes the pollution haven hypothesis (PHH) with respect to home-country environmental regulation. Environmental regulation is shown on the x-axis and measured as SEER, which combines the World Economic Forum's assessment of a country's stringency and enforcement of environmental regulation. SEER ranges from 0 to 7, with higher values indicating stricter environmental regulation. The firm's home-country emissions as a percentage of its global emissions are shown on the y axis. Each bubble pools firms according to their home-country SEER. The bubble size indicates tons of CO_2 exported per million USD of assets for the average firm. This value is listed inside the bubble, together with the SEER range.

Figure 2a. Scope 1 Emissions

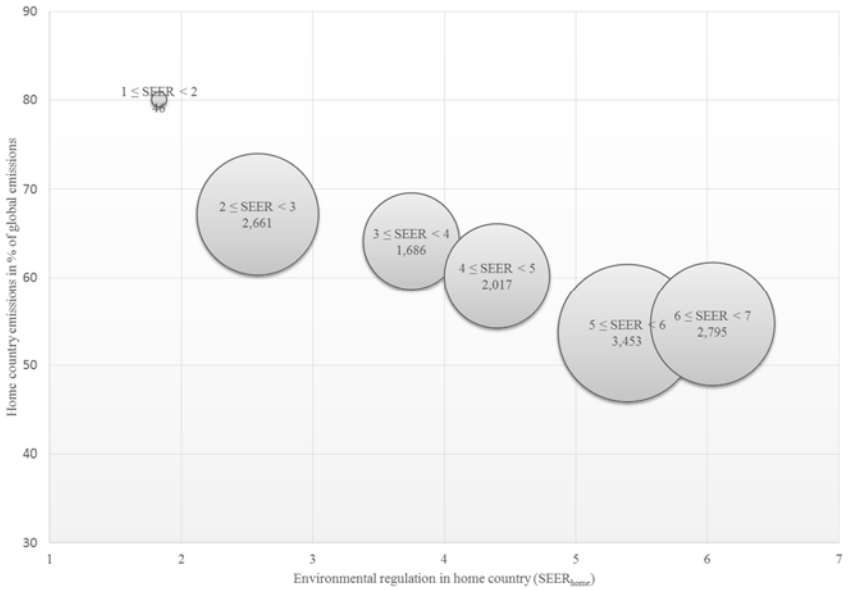

Figure 2b. Scope 2 Emissions

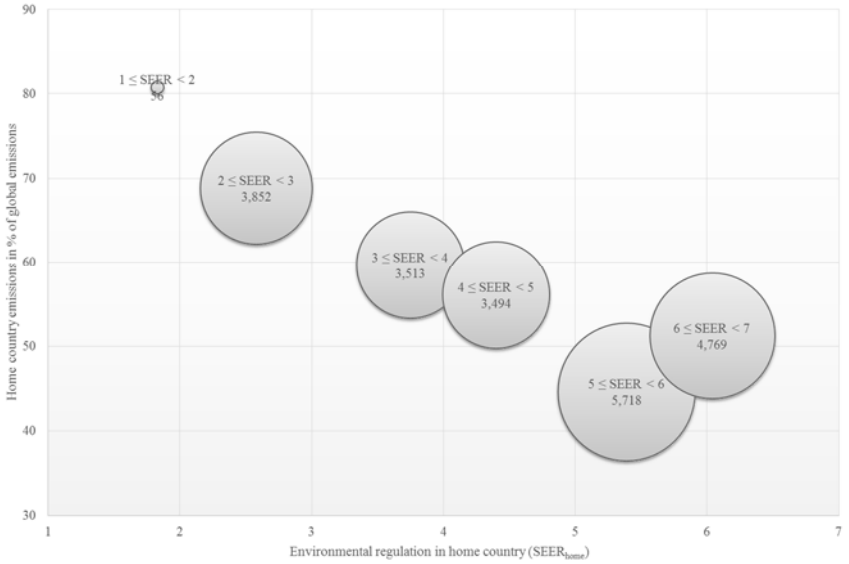

Figure 3. Differences in Environmental Regulation and Emissions in Foreign Countries

The figure presents the differences in environmental regulation and emissions in foreign countries. Figure 3a includes all observations for which SEER in the home and foreign country is known. Figure 3b excludes all observations with zero emissions. The x-axis shows three categories for the difference in environmental regulation in the home versus foreign country. Higher values indicate stronger regulation at home. Thus, the left/middle/right bars reflect country pairs with stronger/similar/weaker regulation abroad. The y-axis shows average tons of CO_2 emissions per million USD of foreign country's GDP.

Figure 3a. Average Emissions

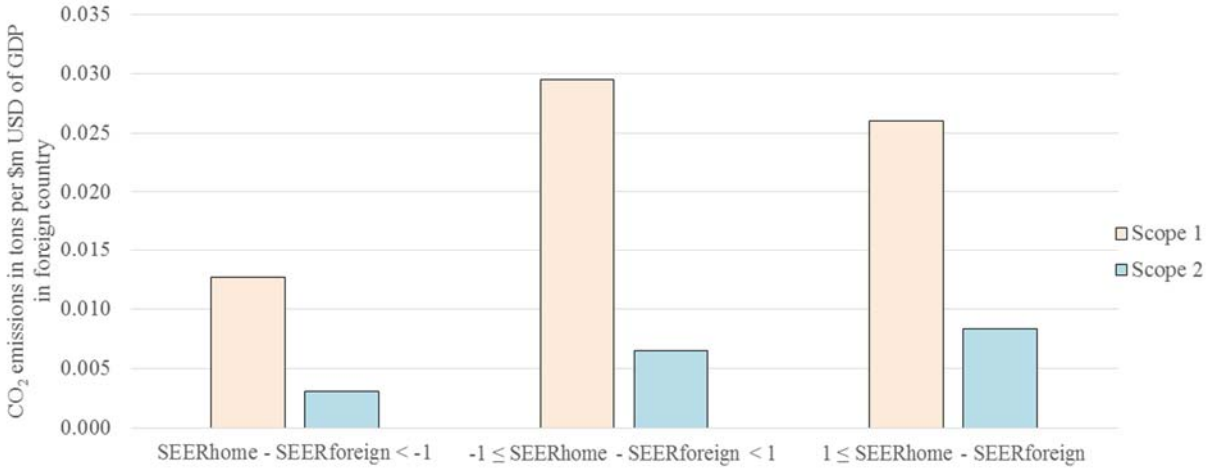

Figure 3b. Average Emissions Excluding Firms with Zero Emissions in a Given Foreign Country

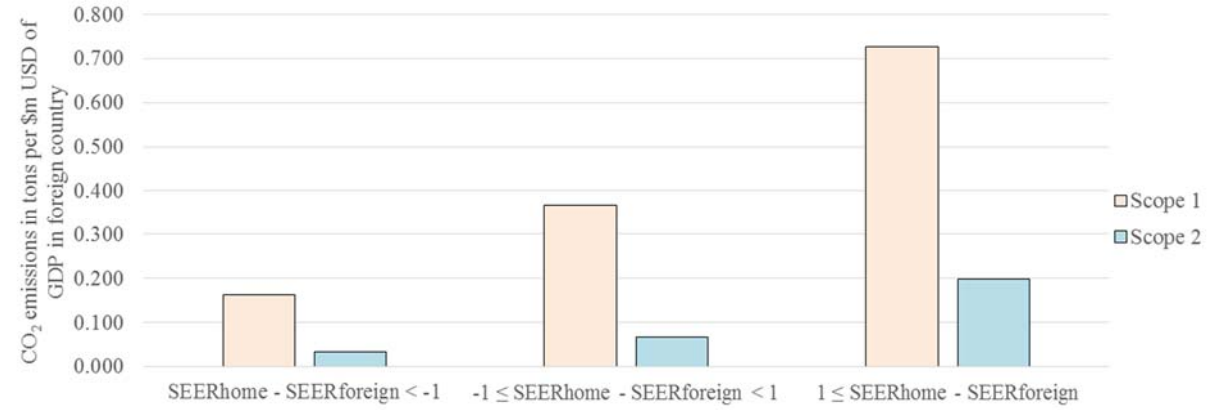

Figure 4. Pollution Intensity, by Industry

This chart shows the CO_2 intensity of various industries in the European Union (2018 member states). CO_2 intensity is measured as the kilograms of CO_2 per Euro of gross value added. For comparability over time, gross value added is measured in real terms (chain linked volumes at 2010 prices) to eliminate the effects of inflation. Pollution-intensive industries are marked with striped red bars. Source: Eurostat, Air emission accounts, Air emissions intensities by NACE Rev. 2 activity (env_ac_aeint_r2): http://ec.europa.eu/eurostat/web/environment/emissions-of-greenhouse-gases-and-air-pollutants/air-emission-accounts/database